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Field of ginseng plants in their first year's growth

Ginseng field in September of fifth year, when the seeds are ripe

Profits from "Freak Farming"

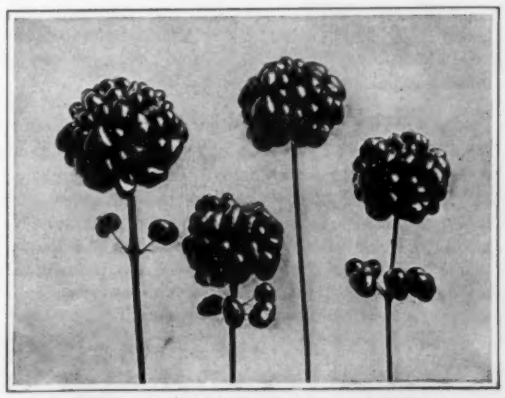
AMONG the unusual industries in America is the cultivation of ginseng, a species of "freak farming" as it is called by the orthodox tillers of the soil.

The root of this plant is the Chinese cure for "all the ills that flesh is heir to." We are apt to scoff at the notion that it is valuable as a medicine, believing that its use is a superstition handed down for generations in China. But it never fails to excite interest, perhaps because the Chinese dealers are willing to pay almost $9 a pound for these precious roots, so that the returns from half an acre of land may be easily $6,000 or $7,000—that is, if you know how to get results.

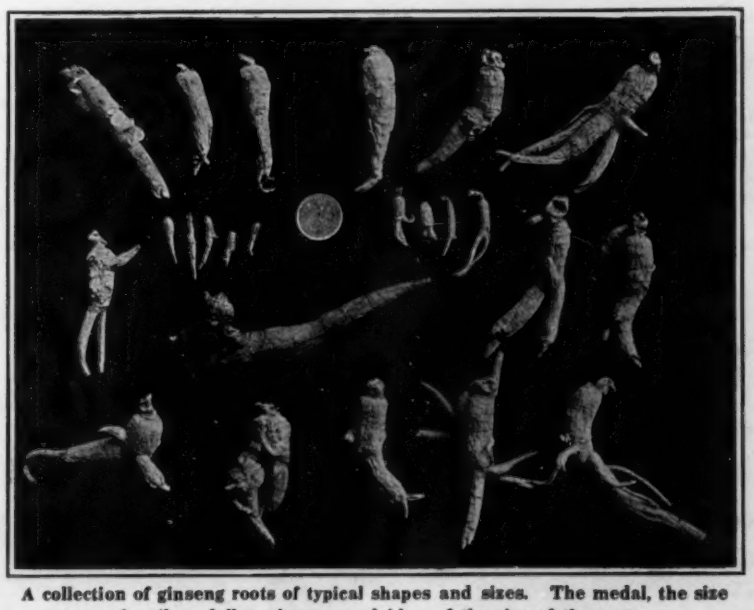
The discovery of the plant on this continent was made over two hundred years ago. The demand from China increased yearly. Then such energetic hunting began that the plant was in a fair way to become extinct as no effort was made to see that reproduction took place, and up to about thirty years ago no one though of cultivating this valuable root.

It was even thought impossible. But a few individuals endowed with an unusual amount of faith and patience took it up as a hobby, experimenting until they finally were successful. Here are a few of the things they had to learn before the industry was launched.

The plant reproduces from seed, but the seeds are unusual. They will not germinate until the second season, or about eighteen months after harvesting. During this time they must be watched carefully; they have to be kept moist, but not too wet or they will rot, not too dry or they lose all their vitality. These things had to be learned through failure. One method of caring for the seeds is to stratify them in moist sand, in the following manner. A box not more than a foot deep is used, with holes bored in the bottom. Then alternate layers of the sand and seed are placed in the box. The sand should be about one inch thick, then a layer of berries which may touch each other but must be only a single layer. Then another strata of sand which must more than cover the seeds and so on until the box is filled allowing at least three inches of sand at the top, with a layer of moss to hold moisture. The top and bottom of the box are covered with wire screen and then buried in a shady place where the water will drain off. It is advisable to put a sloping roof over the box to prevent too much moisture. And care should be taken during summer months to prevent the seed from becoming too dry.



Matured seed heads, three-quarter size



A collection of ginseng roots of typical shapes and sizes. The medal, the size of a silver dollar, gives a good idea of the size of the roots

The patience of the ginseng grower is further tried by the fact that after the seed germinates and the little plants begin to grow it takes five years before the root (which is of greatest importance) is matured sufficiently for use. As it requires such a small area in which to raise a profit-securing quantity, the soil of that area can be worked over and just the right substances added to make the ground suitable for this plant. The growers went direct to the forests, analyzed the soil and claim that almost any sort of ground can be made into proper ginseng soil. That which is most easily prepared is of rather a coarse texture, clay loam mixed with sand, which drains naturally. As the area is small, sand can be added to heavy clay ground to make it porous and mellow.

The transplanting of the small roots is very important, as is also the digging of the mature roots for the market. At the end of the fifth season's growth the roots are marketable.

After careful digging the roots are washed free from mud, the safest way being to spray them gently with a hose. They are then placed in a warm room with plenty of air. All the fibrous rootlets will become brittle as the ginseng dries. Finally it can be rubbed off without injuring the skin. Roots that are hard command a poor price. A short, stubby root is preferred, rather light in color, spongelike to the touch, and light in weight compared to the size. We have been told so often that the Chinaman favors the root that most resembles the human form (for these very often produce queer little shapes like manikins) that we have come to believe that their supposed preference is part of the ginseng "superstition." But the dealers claim that this is not the case. The short single root is preferred by them. Our own doctors are beginning to think that this is no superstition after all and that ginseng is of great value medicinally. Experiments are being made continually.

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The object of this journal is to record accurately and lucidly the latest scientific, mechanical and industrial news of the day. As a weekly journal, it is in a position to announce interesting developments before they are published elsewhere.

The Editor is glad to have submitted to him timely articles suitable for these columns, especially when such articles are accompanied by photographs.

Navy Needs a Proving Ground

SOME twenty years ago, Brown, of Brown Wire Gun fame, showed the writer a letter from Col. Ingalls, containing his calculations of the ballistics of a proposed 10-inch Brown rifle, designed to fire a 600-pound shell with a muzzle velocity of 4,000 feet per second. Col. Ingalls found, among other things (we are quoting from memory), that, if the desired velocity could be attained, and the guns were fired with 43½ degrees of elevation, the shell would rise 18 miles into the air, and that it would fall to earth 49 miles from the gun. The Colonel explained that this enormous theoretical range was due to the fact that the high initial velocity of the shell carried it swiftly, and with very high remaining velocity, into the upper rarefied strata of air, where the retardation by the air and consequent loss of velocity by the shell were proportionately far less than in the lower and denser strata nearer the earth's surface.

It is needless to say that this particular gun was never adopted, and this for the very good reason, among others, that no powder existed at that day, nor in the present day for that matter, that would not have destroyed the accuracy-life of the gun (under the pressures and heat necessary for 4,000 f. s. velocity), in a very few rounds.

Now, although we have not reached the ambitious mark set by Brown, there are naval 6-inch guns today with service velocities of 3,000 feet per second; and we have all read about the German 12-inch gun which has been "strafing" Dunkirk from a distance of 21 miles. Moreover, our latest dreadnoughts will carry a 16-inch, 45-caliber gun of 2,600 foot-seconds' velocity, which has a theoretical range of 36,000 yards at 30 degrees elevation; and there has been completed in our gun shop at Washington, a 50-caliber, 16-inch gun, for our 40,000-ton dreadnoughts, which, if it were fired at the 2,800 foot-seconds' velocity, of which, surely, it will be capable, and at 30 degrees elevation, would rise some twelve miles or more into the air and have a range of over 40,000 yards.

Colonel Ingalls' calculations of 20 years ago, and these for our modern naval guns are purely theoretical; for no one has ever gone twelve to eighteen miles into the air to investigate, and we do not know to a certainty just what the decrease of retardation at these lofty heights may be. That can be determined only by actual test; that is to say by firing our guns under service conditions and having observers placed in suitable stations to locate the fall of the shots.

This means that if the Bureau of Ordnance of the Navy is to verify its calculated ballistic tables, and provide our new ships with sight-setting gear that has been proved by test to be absolutely correct, it must be furnished with a proving ground that will provide a clear and unobstructed range of 50,000 yards.

As matters now stand, the Navy is without any such a stretch of ranging ground; and in spite of its urgent representations, the Bureau of Ordnance has been unable to obtain the appropriation of $1,000,000 for the purchase of the necessary property.

We are spending just now over two billions of dollars on the Navy. In the last analysis, we are spending that money in order that, in the day of battle we may be able to hurl against the enemy, at the greatest practicable ranges, the heaviest practicable shells, *with the greatest practicable accuracy.*

Our new 16-inch guns will fire the heaviest practicable shells, at the greatest practicable ranges, *but for want of a proving ground to try them out, we shall not be able to fire these guns with the greatest practicable accuracy.*

And at the same time our ships will be fighting enemy ships, the range of whose guns is known to a nicety; for at the magnificent Krupp proving ground, entirely free from restriction of range, the German guns are tested under all possible long-range conditions.

The present Navy proving grounds, located in 1891 at Indian Head, Md., are shockingly inadequate for modern ordnance requirements. Not only are they too restricted for long-range firing, but they have no proper facilities for the testing of mounts under the severe stresses imposed by high-angle firing; or for the safe testing of fuses; or for the calibration of guns; or for the proper tests of service ammunition.

The inadequacy of the present proving ground is not a new development; it has been recognized by the Navy for the past seventeen or eighteen years. Each year, due to the increased power of guns, the situation has become more accentuated. Today, ordnance material that has not been properly tested is being installed on our battleships, and the efficiency of our fleet is suffering.

Because of the limited space, tests of shell fuses are carried out at great and constant danger to the officers and men and their wives and families. Things have come to a pretty pass when civilians in Government employ have to run for shelter (as they do), on signal; and the fact, as we are assured, that "they do not complain when fragments of bursting shell go through their houses," speaks more for their patriotic forbearance than for the liberality with which the Bureau of Ordnance is being treated in this matter.

The Navy does not dare to test its fuses in the big 14-inch shells, having no wish to wipe out its proving ground personnel; so it tests them, forsooth, in 6-inch shells.

Not only do fragments fall in the reservation proper, but fragments up to 10 pounds in weight are being picked up among the office buildings and the officers' quarters. These conditions can be remedied by the purchase of a certain piece of land at the small cost of $63,000.

In addition to facilities for testing the heaviest guns at extreme elevation for range and strength of mounts, and facilities for fuse testing and for safe testing of high-explosive shell against armorplate, the new proving ground would make possible the safe and adequate testing of ammunition.

Now, it is an axiomatic truth that no guns should be fired in service in a manner differing in the slightest from that in which they have been fired at the proving ground. *The tragic killing of two nurses on the "Mongolia" would not have happened if the Navy had possessed proper proving ground facilities.*

To provide long-range facilities the purchase of a tract of land on Persimmon Point, Virginia, just above Upper Machodoc Creek and south of Potomac View, Virginia, which is just opposite Lower Cedar Point, Maryland, is proposed. This tract will contain the auxiliary ranging station for large guns. From this point a clear and unobstructed range of 48,000 yards can be obtained across the Kettle Bottom Shoals, and by and beyond Piney Point, some 50,000 yards.

The Bureau of Ordnance should be given these facilities, not merely because they are urgently needed, but also as some small recognition of the fact that the war found the Bureau "on its toes" and ready for a quick and vast expansion of its activities.

The Price of Neglected Brakes

HIGH speed travel is not safe without a means of checking it quickly. The invention which contributed the most to the development of the modern express train was the pneumatic brake. Not only did it have an important influence on fast railroad service but it also made possible the enormously long and heavy freight trains of today. Naturally the inspection of brakes on railroad trains has always received the utmost attention.

As in the case of the railroad train, brakes have played a most important part in the safe operation of motor cars. It does not require more than a moment's consideration to realize that were it not for the efficiency of motor car brakes automobile traffic would not have developed to the position it occupies now. And yet, the inspection of brakes is a matter which has been given very little attention by car owners. A man may use his brakes twenty or thirty thousand times in a year without ever thinking that it is necessary for him to have the brakes carefully examined; and yet a single failure might result in a serious disaster. It seems astonishing that when so much hinges on the operation of brakes they have received practically no care. This is largely due to their location. They are in an out-of-the-way place and not readily accessible.

That automobile brakes need inspection is clearly evident. Traffic records show that the majority of accidents could be avoided if the brakes were in proper condition. Usually we think of the importance of a brake only when a car is traveling at high speed, and yet the records show that sixty-five per cent of all accidents occur when the car is traveling at twelve miles per hour or under. When traveling at this rate it should be possible to stop a car, on average roads, within a distance of fourteen feet, or practically within the car's own length. It should take but three-quarters of a second to bring the car to a stop. Evidently then, most of these accidents are due to the fact that the brakes were not operating properly. To be sure, road conditions have much to do with the stopping of a car even at this low speed; but there is no reason why a car that is equipped with anti-skid tires or with tire chains should not have time enough to stop in almost any emergency. Often the simple tightening of a brake rod or an adjustment of the brake equalizers will make all the difference between safety and the chance of a serious accident.

Because of the almost universal neglect of car brakes, a movement has been instituted to urge the importance of brake inspection. This is a movement which should receive the support of every motorist. It is of the utmost importance to him because no matter how well he may maintain his own brakes he is liable to injury if other motor cars which he meets are not properly equipped. The brake inspection movement is receiving support in all sections of the country from prominent motorists, clubs and officials. Many firms which operate fleets of trucks, have given the movement their whole-hearted endorsement and are having their trucks officially inspected. It is hoped that before the touring season opens this year at least ninety per cent of all the cars in the United States will have their brakes tested.

A chart has been prepared showing what may be expected of the brakes under average road conditions. Taking the formula of the square of the velocity of the car divided by 10.8 as the proved factor of retardation, one is able to figure out readily the number of feet within which a car should be brought to a stop when traveling at different speeds. This factor of retardation decreases to 6.7 on slippery roads and runs up as high as 17.4 on rough worn roads.

We cannot urge too strongly that every motor car owner have his brakes inspected by a competent man, thereby doing his bit toward the reduction of automobile accidents and making for the safety and pleasure of motoring. If the motoring public does not voluntarily support and enforce the movement it should certainly be taken in hand by the Government.

The Government Cinderella

THE Commissioner of Patents reports the condition of the Patent Office to Congress every year, and from the very inception of the present system one report follows the other singing the same plaintive wail as to the inadequacy of the equipment, room and personnel. Always, in these respects, has the Office been from one year to one generation behind the times. No better illustration of the adage of the cobbler who goes barefooted can be given than that of this institution, the Official repository of all the new ideas for the advancement of the material arts, which affixes its approval on the newest things in heating and ventilating devices, office-fixtures and what not, only to see them go into use in almost every other branch of the government service long before they can find lodgment in the Patent Office building. In equipment, ventilation, light and those conveniences associated with modern business methods, the Office is sadly deficient. The Commissioners, from first to last, have entreated and complained, with now and then with some measure of relief afforded, but Congress hears but faintly, and this Cinderella of the government bureaus must continue to be neglected and do its business under its historical disadvantages.

But the world advances, and conditions at their worst, about a generation ago, were much worse than anything we can imagine now. In 1884, the Examiners in reporting to the Commissioner the physical state of their respective rooms referred to the crowding of desks, the floor, tops of wardrobes and windowseats, with accumulations of patents and books of reference; absence of ventilation; and symptoms of poisoning produced by vitiated air. One Examiner in condemning the unsanitary quarters his force occupied stated that "the rooms are unfit for storage purposes even . . . . It is understood by the Examiner that they were designated on the original plan as *coal vaults.*" A similar improvement, a like jump ahead, and the Office may leap into an environment approximating modern conditions and may possess the conveniences which are sometimes depicted in the patents it grants.

Which Is Which In Wire Gages?

OF great assistance to many is the new publication of the Bureau of Standards (Circular 67) entitled "Combined Table of Sizes in the Principal Wire Gages." This table combines in one series the sizes in the American (B. & S.), Steel, Birmingham, (Stub's), British Standard, and Metric wire gages, arranged in order of diameters of wires. It gives the diameters of all the gage numbers in these five systems, in mils, inches and millimeters, also the cross-sections in square mils, circular mils, square inches, and square millimeters. The table is specially useful to manufacturers who wish to determine the nearest equivalent in American or British gage sizes of wires, specified in millimeters or square millimeters, or vice versa.

The paper in question is now ready for distribution. Those interested may obtain a copy by addressing a request to the Bureau of Standards, Washington, D. C.

Engineering

Colonel Edwin A. Stevens, son of the founder of Stevens Institute, died in Washington, D. C., on March 8th, in his sixtieth year. From a family of engineers, Col. Stevens was himself a marine engineer of distinguished ability. Perhaps he is best known as the designer of the first screw-driven ferryboat.

Fording a River with a Tractor.—According to the *Reclamation Record*, it was necessary recently to place two 60-ton drag line excavators on the west side of the Mesilla Valley, of the Rio Grande. It was impossible to convey such heavy machines across the bridges in the vicinity, because they were too narrow and were not strong enough to sustain more than twenty-five per cent of the weight. Accordingly the experiment was tried of running the tractors on their own caterpillar treads across the river bed. The Elephant Butte Dam gates were closed but it was impossible to drain the bed of the river completely. Owing to quicksand in the river bed, platforms had to be used to prevent the tractors from sinking. Some excavation was necessary to turn the waters back of the machines while they were in progress across the river. The first machine made the trip across in one and one-half days and the second in half a day.

Boston's Great Terminal.—Work will shortly be begun on the new "National Terminal" in South Boston, planned to take care of much of our wartime traffic with Europe. The main storehouse, 2,400 feet in length, will be perhaps, the largest single building in the world. It will be possible for six steamers of eight thousand to ten thousand tons each to load at the dock at the same time. It is planned that when the terminal is in full operation 5,000 tons of supplies will leave the pier every day. The storehouse will be of modern factory construction so that it can be easily transferred into factories after the war. There is, however, a possibility that it will be the base for the emergency fleet when peace is declared. The railroad plans call for the establishment of two immense yards in South Boston. Double tracks will be run along the edge of the pier, to enable unloading from cars to ships direct; double tracks will run between pierhead and storehouse; and there will be three tracks along the land side of the storehouse. There will be a supporting yard with a capacity of 300 cars, and a much larger classification yard on made land.

Furnace Design an Exact Science.—The Federal Bureau of Mines, in its Bulletin No. 135, has just reported upon experiments of several years duration in fuel combustion. On the basis of the results obtained, it is possible, starting with the analysis of the coal to be used and the rate at which it is to be burned, to design the furnace dimensions in feet and inches with reasonable assurance of obtaining the desired degree of complete combustion. The process carried on in the combustion space is influenced by many factors, the most important of which are the shape and volume of the chamber, the kind of coal used, especially the amount of volatile matter therein, the rate of firing, the quantity of air supplied over the fuel bed, the rate of mixing this air with the combustible rising from the fuel bed, the rate of heating the coal, and the temperature attained in the combustion space. The qualitative effects of many of these factors upon the rate and completeness of combustion have been known for a long time; but the quantitative data, presented in definite units of seconds, pounds, feet or percentages, have been lacking. To obtain such information a study of combustion in the space beyond the fuel bed was undertaken, and the results of extensive tests are embodied in the bulletin mentioned. While this is especially for those interested in the design or reconstruction of fuel-burning furnaces, it contains much of interest to the general engineer. We abstract a few of the statements which will attract the widest attention. The size of the combustion space required appears to be directly proportional to the percentage of oxygen in the moisture-free and ash-free coal. The percentage of excess air that gives the best results varies with the size of the furnace and the kind of fuel. This explains why in one plant the highest efficiency may be obtained with 14 per cent of CO_2 in the gases, and in another plant with only 10 per cent CO_2. There is a definite relation between the excess air supply and the percentage of CO_2 in the furnace gases. Soot is formed at the surface of the fuel bed by heating the hydrocarbons in the absence of air. It is not formed by the hydrocarbons striking the cooling surfaces of the boiler. As a matter of fact only a very small fraction of the hydrocarbon gases ever reaches the surface of the boiler, and the decomposition of this fraction is prevented by the cooling effect of the contact. So the cooling surfaces do not cause the formation of soot; they merely afford a convenient place for it to collect and avoid complete combustion. It seems that most mechanical stokers are smokeless not because they burn the smoke, but because they burn the coal in such a way that very little soot or smoke is produced. Hand-fired furnaces are smoky because soot is produced in or near the fuel bed, and cannot be burned in the limited combustion space of such a furnace.

Science

Electrical Methane Detector.—For some years the U. S. Bureau of Mines has been working on an electrical device for detecting methane (fire damp). According to a recent report, the detector promises to become a device that will instantly detect less than 0.25 per cent of gas. The main difficulty has been to make the sensitive part of the instrument durable.

Kara Sea Route in 1918. Several notes on the utilization of the Kara Sea route to Siberia have appeared in these columns. The latest development of the subject is the direct sailing of steamers from New York for the Ob and Yenisei Rivers. This plan was inaugurated experimentally last year, and sailings are announced for next July. The Siberian rivers will be reached in September, and goods will be transshipped to river steamers. This year, for the first time, hydroairplanes will be used to determine the ice conditions in the Kara Sea so that the steamers may take advantage of areas of open water.

Melting Aluminum Chips.—Fine aluminum chips, such as are produced in the machining of the aluminum alloys used in motor-car construction, are hard to remelt without excessive loss, a loss of 40 per cent being common. According to the Bureau of Mines, the total loss from this cause throughout the country amounts, with aluminum at its present price, to $600,000. The Bureau has recently published some valuable suggestions for minimizing this loss. The main cause of trouble seems to be the lack of ready coalescence of the metallic globules, and this means that the problem is one of colloid chemistry applied to metals.

Effects of the War on the Birth Rate.—In his recent presidential address to the Royal Statistical Society, Sir Bernard Mallet declared that the United Kingdom has lost by the fall in births during the war more than 500,000 potential lives. During the same period he estimates that Germany has lost 2,600,000, and Hungary 1,500,000. The greater decline in the birth rate in the Central Empires is ascribed to the fact that the poorer classes in those countries have suffered greatly in health and vigor on account of the war, while the corresponding classes in Great Britain have actually enjoyed more favorable conditions than in time of peace.

Malaria in England.—Malaria was once common in certain parts of England, but as a result of drainage and the use of quinine, it was completely stamped out, notstanding the fact that anopheline mosquitoes remain in the country. The parasitic cycle was broken, and the insect was no longer infected. Now comes the report of a recrudescence of indigenous malaria in England. According to a circular issued by the Local Government Board, many men have contracted the disease while fighting on the eastern war fronts, and have brought it home with them; thus they serve as foci of infection for the civilian population. Measures are being taken to deal with the carrier mosquitoes.

The Great Wall of China.—An examination of the bricks and mortar in the Great Wall of China was recently made at Shanhaikwan by Mr. J. C. Witt, a chemist attached to the Bureau of Science, Manila. Mr. Witt reports that the bricks are so weak that pieces may be easily broken off with the fingers. They are much larger than ordinary building bricks, gray in color, and resemble pumice somewhat in structure. The mortar, which is pure white under the exposed surface, is much stronger than the bricks. The tradition that the bricks were dried in the sun only was confirmed by laboratory tests. If they had been dried in a kiln the appearance of the wall would have been considerably different and its strength and durability would have been much greater. The general appearance and analysis of the mortar indicate that no sand was mixed with the lime.

A Useful Map Projection.—An interesting contribution to the vexed question of map projections is made in Special Publication No. 47 of the U. S. Coast and Geodetic Survey, "A Manual on Lambert's Conformal Conic Projection, with Two Standard Parallels," by C. H. Deetz. This is the projection of the official map of France, and is used in the war zone for the new French battle maps, replacing the Bonne projection heretofore used. The Lambert projection is especially adapted to mapping countries of predominating east-and-west dimensions; the United States, for example. Its meridians are straight lines and its parallels arcs of concentric circles. For a map of the United States the maximum error in scale is reduced from 6½ per cent in the polyconic to 1⅛ per cent in the Lambert projection. The merits and defects of these two systems of projection are, in a general way, in opposite directions, so that the shapes and extent of the areas to be mapped should decide which of them is preferable. The new publication discusses the uses and limitations of a number of well-known map projections, the property of conformality in modern map making, and the Lambert zenithal (or azimuthal) projection.

Automobile

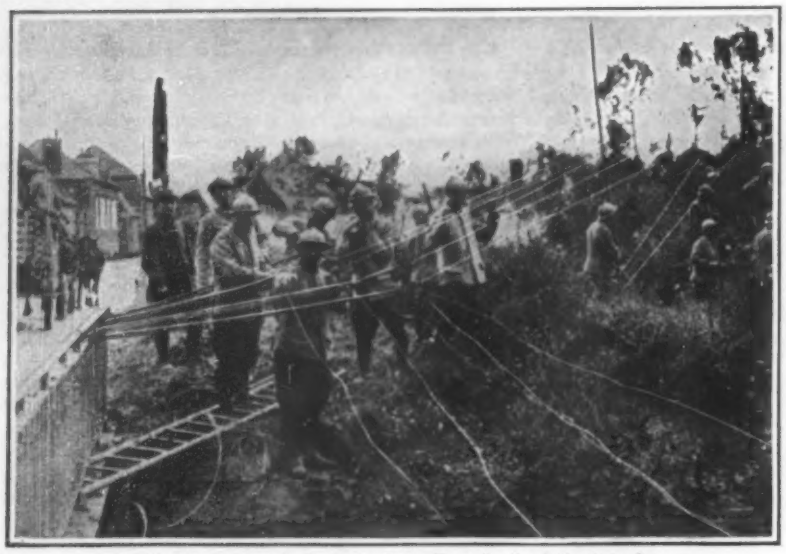
The "War Chauffeuse".—Many enthusiastic reports have come to us from the other side about the excellent work that women are doing as drivers of motor cars, but that there is another side to the picture is suggested by a testimonial recently incorporated in an advertisement of a British automobile manufacturer. This testimonial is from a doctor, who is something more than the typical British humorist when he says of the car in question: "Anything which will stand up to the efforts of my late chauffeuse for seven days each week for months on end must be passably good stuff."

Brakes and Accidents.—It is estimated by competent authorities that the majority of automobile accidents are the result of side slips due to defective braking. It must not be inferred, however, that the brakes themselves are in all cases defective, but rather that their proper adjustment has not been maintained, and that they were not used with judgment. The operation of a brake necessarily involves wear, so this cannot be charged as a defect against the manufacturer; and it follows that systematic and periodical attention should be given to the brakes to keep them adjusted so that they will operate effectively. Too many car owners, however, have neither the ability nor the inclination to take care of their brakes, or to use them with discretion, and consequently are a standing menace to the community. So the brake question constitutes a problem for serious consideration.

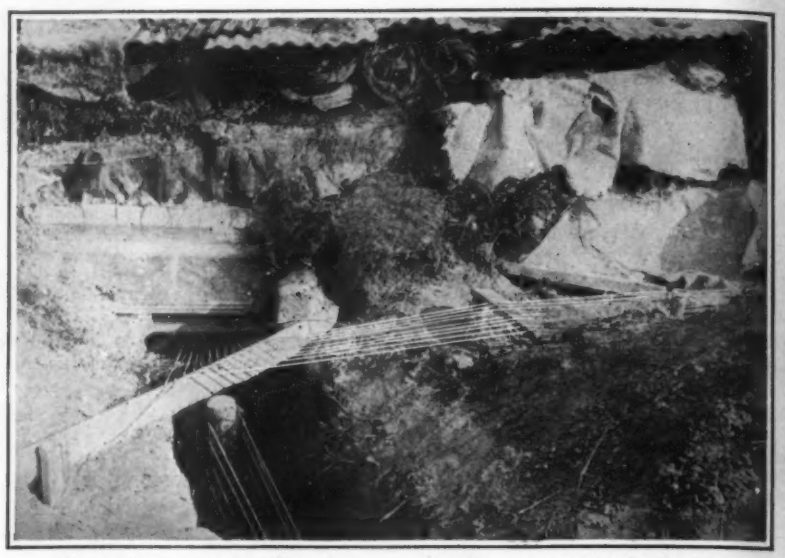
Motor Transportation.—We have been accepting the wonderful work done by the motor truck in France as something due to special circumstances, but the railroad situation in this country during the past year has brought it home to us that there is much in this army experience that can be applied to our home conditions with decided advantage. As a result there are being organized in various parts of the country motor transportation lines that will not only be of great immediate value, but there is no doubt but that many of these lines will become permanent institutions. It is not as yet known over what distances motor trucks can be economically operated, and of course conditions will be considerably modified when our railroads get back to their normal, pre-war status; but the experience that will be gained in the meantime will enable the promoters of the new lines to put their business on a sound practical basis, that will guarantee to shippers rapid movement of goods at equitable rates.

Local Laws and Motor Transportation.—Long distance motor truck lines promise to become a prominent factor in solving many of our transportation problems, and on the success of these enterprises state laws and local regulations will undoubtedly have an important bearing. If the restrictions now on the statute books of many states are strictly enforced interstate motor transportation would be impossible. For example: Many states limit the period during which motor vehicles owned in another state can operate within their boundaries without taking out a state license. Such petty restrictions might easily make the operation of a long distance motor transport line on a large scale an economic impossibility. Innumerable technical regulations in the towns traversed on such a route would constitute further serious impediments to progress. It is evident that to make inter-state motor transportation feasible either the states must harmonize their laws, or the Government must step in and promulgate regulations to be applied uniformly in all states. The problem is a difficult one, as the upkeep of the roads must be provided for, and motor transportation companies cannot expect the country to provide trackage for them wholly free of cost.

The Motor Truck Demonstrates Its Ability.—A notable example of what the motor truck can do in long distance transportation is the fleet that a big rubber house has been operating for some months between Akron, Ohio, and Boston, a distance of 740 miles by the route they have followed. These trucks are operated on a strict time schedule, and, even during the severe weather and road conditions of the past winter, no serious delays occurred. Some of this immunity from delay must be attributed to the fact that over a particularly difficult portion of the route, across the mountains of Pennsylvania, the local authorities kept the roads open for the benefit of the Government trucks that have been operating between Cleveland and the coast; but on the whole the experiment has demonstrated the entire feasibility of motor transportation over long distances. The experience of this fleet will be of great value to all users of trucks; and one of the points developed is the desirability of equipping trucks intended for long distance work with a greater power ratio than is required for ordinary local work. The experiment also calls attention to the urgent need for general highway improvement, especially in bridges, for the Akron-Boston fleet, on account of numerous weak bridges in New York and Massachusetts, has been compelled to adopt a much longer route with greater mileage than should be necessary.



Poilu linemen stringing telephone lines back of the trenches "somewhere in France"



Copper "nerves" of the French army on the Somme, entering the dugout which serves as the central

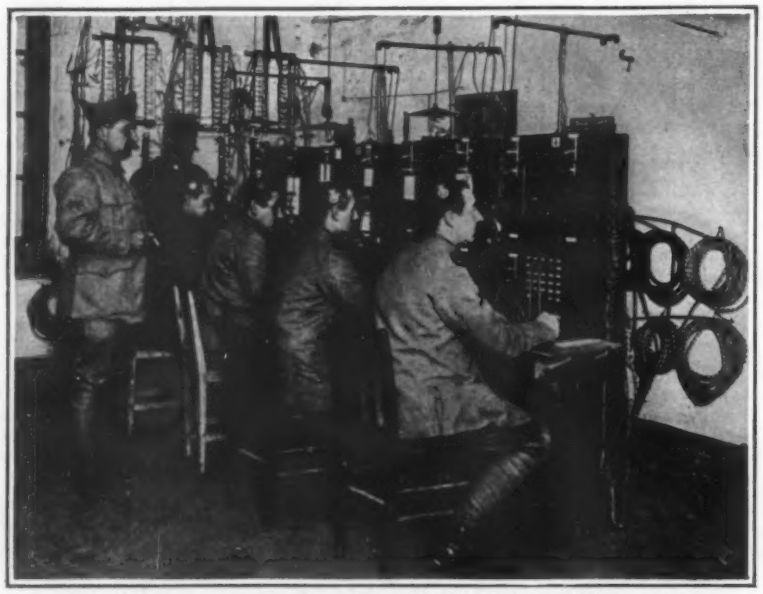
The Telephone in Khaki

How and Why the Telephone is Extensively Employed at the Front

THE telephone system is continually being referred to as the "nerves" of an army, so there is nothing new in drawing that comparison. But for want of something better, it continues to be used by everyone. After all, the military telephone system is like the nerve system of the human body in that it serves to keep the various units in constant touch with the directing head. In large measure it accounts for the remarkable precision shown in many offensive and defensive operations in which hundreds of thousands of men and thousands of guns and hundreds of supply trains act as one. In truth, the telephone is indispensable to the modern general.

To be really effective, a military telephone system must connect with every unit of the fighting forces of a country. So the thin wires spread out from the army administration to the various parts of the line and even to advanced listening posts. Back of the line, where there is no danger of enemy shell fire, the wires are strung on poles in the usual manner; but in the fighting zone the wires must be protected somehow or other. Early in the war, before artillery had reached its present tremendous destructive power, telephone wires were laid in shallow trenches and then covered over, affording ample protection to the "nerves." But a barrage fire or drum fire which can smash concrete shelters with six-foot roofs and penetrate 30 feet into the earthen walls of an underground dugout, is not going to spare delicate telephone wires, no matter how deep they may be buried in the battlefields by khaki-clad linemen working with pick and shovel—and under fire.

Today, unless it be on a quiet sector where very little artillery action takes place, no attempt is made to bury the telephone wires. Instead, diminutive poles with cross arms are employed, with the bare copper strands supported on insulators a few feet above the ground so as to form an "air" line. These poles are inconspicuous, and any broken wires can be immediately detected by the telephone patrols which constantly test, repair and protect the various lines. All nations at war maintain telephone patrols, for in the proper functioning of the system often rests the destiny of the army and the nation.



Typical telephone central on the French front, with its soldier-operators and sergeant in charge

Of the various ways of regulating barrage fire, especially the advancing barrage used in protecting infantry during an attack, the telephone is one of the most common. Men known as "linking officers" go forward with the infantry waves, paying out wire from reels strapped on their backs or carried in their hands. Over this wire the artillery officers with the infantry can keep in touch with the batteries in the rear, and thus regulate the wall of exploding shells for the greatest harm to the enemy and for the utmost protection to their own infantry.

Gas attacks are generally detected by observers in advanced posts or "listening posts." Some observers, have remarkable olfactory powers; these men, upon scenting the attack, immediately telephone the alarm to the trenches, permitting the soldiers to don their protective masks before the deadly gas arrives.

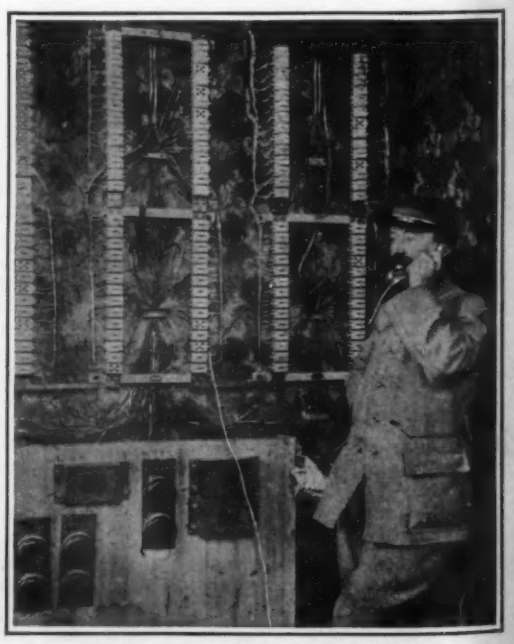
Central stations are installed at convenient points just as in the case of any metropolitan telephone system. A chateau, hovel, bomb-proof, deep dugout—any of these and many others may serve as quarters for a telephone central. The wires are brought in to panel boards and thence to switchboards manipulated by men in uniform. All kinds of instruments are at hand for testing the wires and trunk lines, for trouble must be immediately detected and corrected in a system on which so much depends.

Tapping the enemy line is quite commonplace on the

(Concluded on page 263)

A limbless tree "doing its bit" as an improvised telephone pole

Far below the surface: A shell-proof telephone central



Panel board which permits all lines to be tested

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British air pilot releasing a pigeon with the message for help

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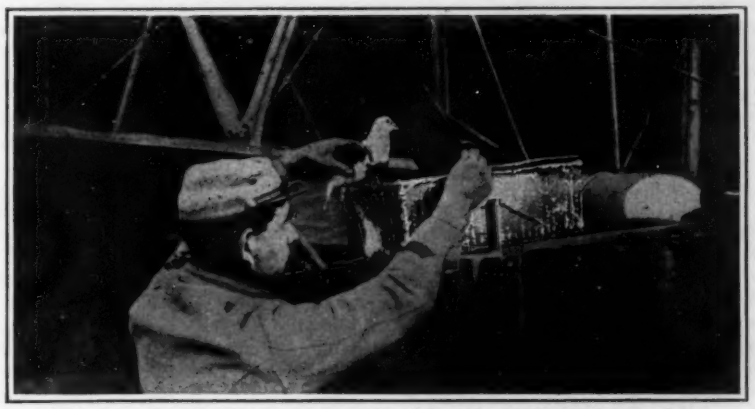
Attaching a message to a carrier pigeon, aboard a British submarine

Despite Wireless the Carrier Pigeon Survives

AFTER all, the best kind of report is a written one. Perhaps that is why the French and British naval air services employ carrier pigeons in transmitting reports from seaplanes to the base; but however that may be, the fact remains that this time-worn practice is being resorted to in addition to the usual wireless installation.

In one of the accompanying illustrations appears a British naval airman in the act of releasing a carrier pigeon in order to summon help. It is reported that many lives have been saved in this manner. Another illustration depicts a British naval officer on the bridge of a submarine, fixing a message to a carrier pigeon. The last illustration shows a French airplane mechanic placing a carrier pigeon in a basket on board a big F. B. A. flying boat.

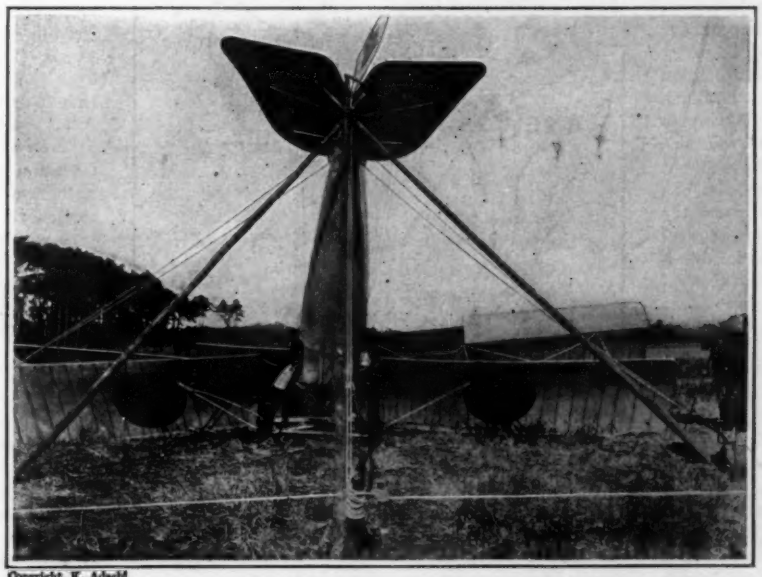


This carrier pigeon is one of several which will accompany the seaplane observer and carry his reports to the base

Propping Up the Fallen Airplane to Study How It Fell

IN Japan they have a rather queer practice of propping up fallen airplanes so as to maintain them in the position in which they struck the ground. Queer, to be sure; but the practice is most commendable since it permits a careful investigation to be carried out in order to determine the causes of the accident.

A typical case of a Japanese airplane accident appears in the accompanying illustration. This is the airplane Sei-No. 2, which on January 17th last crashed to earth and killed its pilot, Lieutenant Sakamoto. The craft was photographed in exactly the posture and position in which it struck the ground at the Tokorozawa military flying field. Immediately after it fell, the men in charge built the supports so that the exact position of the biplane could be maintained despite the winds which might otherwise have wrecked it



Copyright, K. Adachi

Following its crash to earth, this Japanese biplane was propped up for future investigation and study

Shoveling Poisonous Gas Out of Trenches

WEIGHING considerably more than the atmosphere, the poisonous gases employed in modern warfare always seek lower levels. Thus the gas clouds penetrate trenches and deep dugouts, and in most cases it is a matter of many hours before they become sufficiently diluted with the atmosphere to permit of safe breathing. So the matter resolves itself into a problem of driving the poisonous fumes out of the trenches and underground shelters, or at least thinning them out until the air is again made safe.

In this connection the accompanying illustration is of considerable interest, for it shows how American soldiers in France "shovel" poisonous fumes out of their trenches. Attached to their usual shovel is a sort of canvas scoop or "flapper" which permits the men to heave the heavy gases over the parapets and to beat the fumes and dissipate them in the surrounding air. The two Americans, in this case, are shown wearing the respirator type of gas protector, as distinguished from the gas hood or helmet.

Copyright, Committee on Public Information

American soldiers "shoveling" poisonous gas out of a trench

Insuring Aircraft Against Fire

AS a result of an inquiry conducted by the National Advisory Committee for Aeronautics into the subject of fire insurance for aircraft, it was found that most of the fire insurance companies were not writing or contemplating insurance for aircraft.

One large fire insurance company, however, has announced that it is now prepared to issue such insurance. It appears therefore that other companies will take similar action and that before long such insurance may be written generally.

Briefly, the new form of policy is a cover against fire while in flight or upon the earth, or upon any lake or river, or in or over the coastal waters of the United States, excluding Alaska, Porto Rico, etc. It will also cover the shipment of aircraft upon any railroad or other conveyance within the limits of the policy against burning, sinking, derailment, or collision of the conveyance.

Caution is advised to avoid the congestion of hangars which are usually remote from fire protection and sometimes built close together; they should be separated by proper distances, to the end that the burning of more than one hangar may be avoided. Separation of hangars will also allow time for the removal of aircraft from endangered hangars.

The Current Supplement

"THE problem of the method of evolution is one which the biologist finds it impossible to leave alone, although the longer he works at it the farther its solution fades into the distance." This statement is the introduction to a paper on *The Problem of the Method of Evolution* that will be found in the current issue of the SCIENTIFIC AMERICAN SUPPLEMENT, No. 2203, for March 23d; nevertheless, the paper will be found a valuable addition to the discussion of the subject. One of the astonishing things about the great war is the number of ancient weapons and devices for protection, long ago abandoned and supposed to have been entirely superseded by modern inventions, that have been resurrected and put to good uses within the last few years. Some of these are described and illustrated in an article entitled *Ancient Defensive Armor in Modern Warfare*. The paper on *War Psycho-Neurosis* is concluded in this issue. *Oysters: The Food that has not Gone Up* gives some interesting information about an important product of our fisheries, and there are a number of excellent photographs from our Southern fisheries. An article on *The Fourth Dimension* will be appreciated by the mathematician and the logician. It is illustrated by a number of diagrams. *The Treatment of Severe Burns with Ambrine* describes results of a procedure that has not only been found of extreme value in our armies abroad, but is also of practical interest in many branches of manufacture where accidents from burning are not infrequent. A considerable amount of other interesting and valuable matter will also be found in this issue.

Strategic Moves of the War, March 12th, 1918

By Our Military Expert

THE latest and most interesting news of the present world struggle has dealt more with the astonishing political developments on the eastern front than with the raids both aerial and on the actual battle lines that have characterized for days the western theater of war from the North Sea to Switzerland. Germany's latest peace terms to Russia have practically contained the requirements of the surrender of a large portion of Russian territory, the disbandment of her armed forces and the regulations by Germany of all trade and the other usual occupations of a great people. The facts are that there is no longer any Russia as regards national sovereignty or independence; the consequences of a few months of the anarchistic Bolsheviki rule can now be plainly seen. Russia has to all intents and purposes ceased politically to exist. This giant of the north, so long feared by the Central Powers on the west and viewed with distrust by China, Japan and England on the east, has apparently disappeared as a world power—as completely as has been the case in the wiping out of little Serbia or in destroying the integrity of Rumania.

There can now be no denying the fact that the great powers given Germany by her eastern successes have made her stronger and more to be feared than when the present war was begun nearly four years ago. And, if this war leaves her the control of the vast empire that has so easily fallen under her influence or into her hands, the world at large will henceforth live under the shadow of a danger far greater than was the case before the war began. The acceptance by Russia of Germany's peace terms cuts off from her territory nearly four hundred thousand square miles, an area almost twice as large as the German Empire in Europe; it also takes away from her rule a population of fifty or more millions of those who have for centuries known no government other than that of Russia. It is evidently the intention of Germany to create a series of buffer states on her eastern frontier controlling all Russian trade and economic life while the states themselves are to be under German tutelage. The Ukraine, whose frontiers are left most conveniently undefined, has been put nominally under Austrian sovereignty. But this great extent of country will be kept under strict economic dependence upon Germany, for the latter will control Odessa and the Black Sea, thus cutting off the remainder of Russia from a southern outlet to the Mediterranean; she will also prevent this granary of Europe from aiding in the great problem of feeding the other continental countries. In the north the boundaries set upon Livonia place the Germans within sixty miles of Petrograd; the practical control of Finland combined with its commercial domination gives the mastery of both shores of the Gulf of Finland into German hands and effectually closes to Russia any access to the Baltic Sea except upon Teuton terms. And here the Scandinavian states have just cause for alarm for there is every evidence that plans are on foot for establishing German influence over them and of making of the closed Baltic Sea a German lake.

The recent denunciations of these countries in the German press accuse them of being in agreement with the Entente Allies and give them warning that they can expect little consideration from Germany. That these countries can be accused of being over friendly to the Entente, certainly in the case of Sweden, would be amusing if it were not so serious. Sweden has been a most constant friend and persistent worker for German interests, as the ruling family, the army and the universities have been most outspoken in Germany's favor. According to newspaper accounts more than fifty per cent of the steel that Germany has used for the manufacture of munitions has been obtained from Sweden. Now, however, when it is no longer necessary to cultivate the friendship of Scandinavia and in order to have a good excuse for exercising her strength in the north and to insure the control of the Baltic Sea, Germany feels that she is in a position to dictate her will upon her weaker neighbors.

The latest territorial claims by Germany upon Russia have led to the cession to Turkey of practically all of the southern part of Trans-Caucasia for these claims call for the surrender of the regions known as Batum, Kars and Karabagh. Very little has as yet been published as to the limits of this new cession made ostensibly as a reward to Turkey for her aid to the Central Allies. But in reality the true reasons have been for the purpose of assuring to Germany an ample supply of copper and manganese ore, the latter being so essential in steel manufacture on any large scale. In the vicinity of Batum are some of the largest deposits of manganese and of copper ore in the world; the easy shipment across the Black Sea to any of its western ports and thence to Germany assures the latter of an ample supply of ordnance material for war purposes. There is a railway extending from Batoum to Baku and its oil fields. At Baku are some of the best oil fields in the world, and, combined with the supplies that can be obtained from Rumania, they will give to Germany all the petroleum products that she will need. Thus three of her prime necessities will be supplied, enabling her to continue her present war activities as well as to prepare for future eventualities. Not every one has realized what has happened or may happen as the results of Germany's recent successes, both military and commercial, by her gains in Russia; only the future can disclose on what a scale she will make use of her opportunities and of the fruits of her victories, at last so easily gained and so fully followed up to her own advantage.

Much has been said of a proposed German invasion of Siberia with a march to Vladivostok and the Pacific. But undoubtedly she is too shrewd to risk a war with Japan that would call for millions of men and treasure. In addition, the transport difficulties across the almost boundless plains of Russia would be insurmountable; food and military supplies to support large armies, thousands of miles from their bases, could not be moved rapidly enough to hope for any success in a military sense. Undoubtedly Germany's wish is to bring peace to the eastern front and to Rumania and then to bring matters to a crisis in Asia Minor and the Balkans. The stumbling block in the latter country is the Allied army at Salonica; that once out of the way, an advance on Palestine with a check on the British forward movement there would be the next consideration.

Once the English forces could be defeated there, Mesopotamia would be almost immediately at her mercy and no doubt the Tigris valley would soon be swept clear of opposition as far as Bagdad and the Persian Gulf. It can be said that Germany, almost of a certainty, has no intention of threatening Japan on the east or of making any drive through Russian territory against India.

The German arrow aimed at India

Distances by that route are too great. Germany, in a word is still adhering to her Mittel Europa schemes, for, by separating from Russia the Trans-Caucasian provinces, she is adding to the enormous territories in Middle Europe and Southern Asia over which it is her intention to gain political and economic control. Trans-Caucasia will be as truly German by control as will be Esthonia, Livonia, and the Ukraine in Russia proper. Turkey and the Balkan peninsula will also have the same status. Austria is but a German puppet and will have in fact, if not in theory, no independent political existence. She becomes simply a part of the great middle Europe domain. If it were not that the nations of the world are at present under arms to defeat Germany, the whole plan is on so gigantic a scale for extending German control of territory and of resources that the world at large would have cause for fear of the ultimate results. It is therefore now the more evident that Germany must be thoroughly beaten or she will finally master the world; there can be no permanent peace until Germany's present designs are abandoned and until she is confined within her own territory. England especially is menaced in her Indian possessions for beyond Baku and the Caspian Sea lie Bokhara and Turkestan. Through these countries, as well as through northern Persia, it will be easy to reach out to Herat and Afghanistan, the keys to India. In fact, in a recent news telegram from Berlin, the open boast is made that Germany has acquired a direct free route through Russia to Persia and Afghanistan; in other words, there is nothing to hinder her from reaching her goal, which is India. This makes the present struggle, indeed a world war as the danger lies by no means in Europe alone. The possession of the Black Sea and of Trans-Caucasia is indeed "an arrow aimed at the heart of India"; the success of the German ambition here would mean the disintegration of the British Empire and would bring our own country still closer to the shadow of German control. That Germany's final design is to gain absolute political and economic control of middle Europe and of southern Asia is now too evident to be ignored.

On the western front with weather conditions improving day by day, trench raids, aerial combats and artillery duels are increasing in intensity, as the days pass. No great battles have been reported, but the official accounts show great activity on the part both of the Allies and of the Germans. The long advertised German drive has not yet taken place though there is nothing whatever to prevent its launching at any time. The Germans are still adding to the number of divisions on this front; they have, as far as can be learned, fifteen or sixteen more than the Allies though that does not mean any superior strength since the number of men in an Allied division is larger than in a German one. The Allies also have a superiority in air craft and in guns, though additions from other fronts are constantly being made by the Germans, thus diminishing such superiority. Heretofore, due to fewer guns and the necessity of preparing new troops, no forward thrust by the Central Allies has been attempted; but, if it is to be begun, it will now be not long delayed. There is much increased training activity behind the German lines, especially on the front occupied by the Belgians and French, where open warfare methods are being employed in drill.

It is uncertain at present whether this training portends the long expected offensive or whether it precedes a withdrawal on a wide front to force fighting in the open. It may even be the training is only to keep the men in proper condition for any style of combat that may arise. In the last few days strong attacks have been made by the German forces on the Flanders front and in the vicinity of Ypres, where there had been a marked increase in offensive activity. There have been heavy artillery action and infantry engagements all along the fronts from the Craonne plateau to Rheims, Verdun, and on into the Vosges mountains. In other words, there has been a "nervous activity" apparent over the whole western front; this leads to the belief that a drive in force either by the Germans or by the Allies is a matter of a few days only.

Some experts hold, however, that Germany has no intention of launching a new drive in the west since nothing decisive can be expected here; they are inclined to believe that her greatest efforts during the present year will be made in Asia Minor, on the Salonica front, or in Italy. An unsuccessful offensive on the western front would not only be costly in loss of men and material but would lead to a reaction on the part of the German people that would place the military party now in power in great jeopardy. Germany is well placed on this front for defensive operations while she feels confident of her ability to drive the Macedonian army of the Allies back upon Salonica and the sea. The expulsion of the Allies from Macedonia would not only give to Germany the long desired outlet to the Mediterranean but would also free the Balkans and remove the threat of a severing of her communications with Constantinople. While the Salonica front is a long way from Germany and even Austria, it is much farther away from England and France. The submarine problem in the Mediterranean is a serious one for transportation; in an emergency, troops could be hurried through Italy and shipped across the Adriatic and through Albania. But the great hope of the Allies here is the organizing and equipping of the Greek army.

Renewed possibilities of a stroke on the Italian front are indicated in the latest dispatches published in the newspapers. There have been many movements of troops observed and formations of new tactical groups similar to those preceding the November drive, have been noted. Large columns of troops are reported as moving in the valley of the Astico River, in the Lagarina valley from Trent and in the Giudicaria valley leading to Brescia.

There is also an increasing concentration of artillery back of the enemy's lines; these guns are presumed to have been brought from the Russian front. The best Austrian army leaders have also been sent to this front, showing the importance and scale of possible future operations. However, heavy snows have so far thwarted all efforts for active operations and these conditions may hold for some time to come. In the meantime, air activity has been very marked, the superiority of the Allies in this respect being most evident. Everything indicates that the enemy will take soon the offensive along the mountain area, possibly endeavoring to come down the valley of the Adige into the plains of Italy. But the Italians have now fully recovered from the disasters of last autumn's campaign and are operating in close conjunction with the British and French troops now at the front in Italy.

Correspondence

The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.

Lime Water Bread

To the Editor of the SCIENTIFIC AMERICAN:

In the issue of the SCIENTIFIC AMERICAN of February 9th, you published an article about war bread where you advocated the use of lime water instead of milk or water, when the new war flours are used. I have had four years of domestic economy at Lewis Institute, and was very much interested in your article, so tried using lime water in mixing my bread, and thought you might be interested in the results. I have tried making the bread with it twice, and find it works beautifully using two-thirds war flour, one-sixth rye, and one-sixth oatmeal. The bread rises well, is sweet tasting and as your article says keeps moist for several days. I am enclosing a recipe for the bread, and if you care to pass the information on to the housewives, you are at liberty to use it:

One cake compressed yeast dissolved in ¼ cup warm water, 1 cup steel cut oatmeal cooked 10 minutes in 1 pint of water, 2 tablespoons sugar, 2 tablespoons fat, 2 tablespoons of salt, ½ cup of lime water, 1 pint water, 2½ cups rye flour, 6 to 7 cups war flour.

Cook oatmeal, let cool until *luke warm*; add yeast and other ingredients; knead well, let rise until double in bulk; knead again, shape into loaves; put in tins and let rise again; bake in moderate oven about fifty minutes. This makes three good sized loaves.

I was unable to get the lime water made up one part in three thousand, so bought a 15-cent bottle of lime water at the drug store, and find it works very well using *one-third* cup of it and one pint of water for the liquid.

I want to thank you for the helpful idea.

CLARA M. GOTT.

Chicago, Ill.

The Marine Corps Signal Battalion

To the Editor of the SCIENTIFIC AMERICAN:

I have been asked many times since I have been in Philadelphia, by men, if the Marine Corps has a Signal Battalion. I believe, therefore, that if you would give this matter publicity, it would serve a great deal of good, in that it would inform so many young men that the Marine Corps has a Signal Battalion, and its home station is Philadelphia, Pa., where the Signal Battalion has a school for training radio operators, telegraphers, electricians, linesmen, repairmen, gas enginemen, motorcyclists and operators of switchboards and operators of night and day signalling apparatus. You might further state that unprecedented opportunity is given applicants to join this Battalion, who are experienced as telegraphers, radio operators, gas enginemen, linesmen, etc., or those who have a desire or aptitude for learning those things; he is sent direct to the Signal Battalion at Philadelphia, instead of going through the recruit depot. Here at Philadelphia, he is given his military training, as well as, his training in branches above mentioned.

It is a chance for a man to affiliate himself with men of the Battalion, who represent twenty odd colleges and universities, and almost every profession and trade known: Civil engineers, lawyers, law clerks, draftsmen, machinists, chauffeurs, motorcyclists, repairmen, linesmen, switchboard operators, students, etc.

The Marine Corps Signal Battalion offers to likely men the chance of patriotic service, cosmopolitan association, liberal education and technical training. If any young man desiring to enter this Battalion will drop a line to Major J. J. Meade at these headquarters, he will be glad to give him any information he desires, or to see him here and take him over our work.

MILLARD F. STEVENS,
Sergeant Major,
Signal Battalion, U. S. M. C.

Philadelphia
Navy Yard.

Physical Environment

To the Editor of the SCIENTIFIC AMERICAN:

I quote the following from "Geographic Influences in American History," by A. P. Brigham:

"We do not yet know how much physical environment molds the mental and spiritual life. We cannot trace geographical influences in a complete way, but we gather hints of their power. Unless one is plying the Hudson for trade, Irving is the best guide to the river. His tales of humble domestic scenes in the 'Legend of Sleepy Hollow,' are pictures, and the woods in which Rip Van Winkle slept are the living forests of the Catskills.

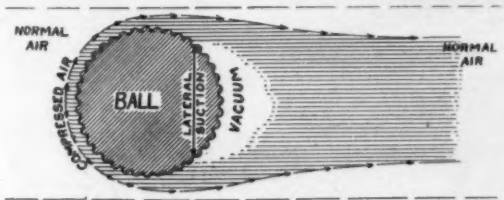
"The reader of 'In the Tennessee Mountains,' or of 'The Prophet of the Great Smokies,' finds true pictures of the forests and hazy mountain slopes of the Southern Appalachians. But he finds also a human type not to be met elsewhere in the United States. He is courageous, original, reads the sky and forest in lieu of books, and is little troubled by the outside world. Retired from all the world, these men reveal the effects of a stable environment in a remote region."

This leads me to say that physical environment influences in a large way one's thinking and practices in life. I travel throughout the Tennessee Mountains, as a Sabbath School missionary, visiting families in their homes, and meeting the people in public meetings in district school houses, and I am impressed with the ruggedness and independence of thought of the citizens of this region. I think it is due in a measure to physical environment.

Here you find a class of people as distinct and separate in thought and conventionalities as the Jewish people are to other nationalities. This great highland empire known as the Southern Appalachians has the purest stock of Scotch-Irish and Anglo-Saxon blood to be found anywhere in America. The people have not intermarried with foreigners, and no immigration has as yet found its way into these communities.

The mountaineer is intensely patriotic, and has always been loyal to the National government in great crises. History will bear out this statement. In the present war many of the mountain counties in Tennessee have furnished more than their quota of volunteers. Cumberland County did not have to draft a single man.

In the foregoing county there are 1,879 families, and 1,839 dwellings. There are only 263 tenants in the county. This is an illustration of general conditions throughout the mountains, and shows that the family life, as of Bible times, is an important factor in the development of character. In the mountains, as a rule, every family has its own home. This contributes to freedom and independence of thought. It is a life lived in close contact with nature. The government Children's Bureau at Washington has issued a report which states



The golf ball in flight

that in homes occupied by single families 86 babies in 1,000 die. But in tenements where six or nine families live, 237 babies in 1,000 die.

In the great industrial communities that are now springing up as a result of the war, housing conditions and other matters pertaining to physical environment should be given due consideration. If this law of physical environment holds true in such a marked way with the Southern Mountaineer it will with equal force apply to all sections and conditions of mankind.

JAMES D. BURTON.

Oakdale, Tenn.

White Ant Depredations

To the Editor of the SCIENTIFIC AMERICAN:

Last summer my attention was called to the matter of white ants attacking live trees.

The only cases that I have seen have been small trees, pitch pine or cryptomeria, or small limbs on trees of these species. Also, so far as I have examined, there is first an unhealthy condition of the young bark which causes it to swell and roughen so that when the new ring of wood is forming in the spring, the bark splits open and gives the white ants access to the half formed wood. They thus eat this out without disturbing the bark, while the previous year's growth of wood is left perfectly smooth without a scratch. It bears the mark of the unhealthy condition which gave the white ants access to the underside of the bark.

J. E. WALKER.

Shaowu, Fu, China.

Restoring the Battlefields

To the Editor of the SCIENTIFIC AMERICAN:

In your editorial of February 9th, "Can Shell Scarred Battlefields Be Cultivated?" you suggest that a machine be found which can drive straight across all obstacles, etc.

Would it not be more practical to revive the old system of steam plowing and drag the scraper across the field by means of wire rope?

This, it seems to me, would not only be more efficient than a self-propelling machine, but would be much safer as the operators could be at a safe distance from the scraper.

In case of an explosion from striking a dead shell the only damage would be to the mechanism of the scraper.

C. M. CONRADSON.

Green Bay, Wis.

The Mystery of the Golf Ball

Why Must It Be Rough In Order to Fly True?

By P. A. Valle

ONE frequently hears golfers and others asking the reason for the marking of the cover of the golf ball. The answer always is that the marking is necessary in order to make the ball fly straight. In other words the ball will not hold its flight unless it has some kind of a pattern on its cover; this has been proved beyond any possibility of argument; the smooth ball has a most erratic flight, that, in fact, makes it useless to a golfer.

These phenomena have not, however, been explained by the scientists. It is a subject of much interest and of great practical importance to golfers so it is quite worthy of consideration and elucidation.

Nothing flies well without a tail. This might almost be laid down as a fundamental axiom in general aviation. As boys we have all seen the futile efforts of a sparrow to guide himself when minus his tail-feathers. A kite is useless without a tail. Where would the arrow go without its feather? The old round rifle-bullet was a poor thing compared with the modern bullet that has got its "tail" in its *length and spin*, and an airplane without a tail would cut a sorry figure.

As it is with all of these so it is with the golf ball. It cannot fly well without a tail. It, in effect, has a tail, but it is invisible. That accounts for much of the mystery of the flight of the golf ball.

The golf ball leaves the face of the driver in a well hit stroke at a very great speed. It follows naturally that in front of the ball there is a cushion of compressed air. It follows just as naturally that immediately behind the ball there is something approximating to a vacuum. These are both clearly shown in the diagram. It will be clear that, from the front point of extreme compression to that point where the compressed air regains its normal density, there is a disturbance in the atmosphere in the form of a tube of compressed air, of varying density and containing a small vacuum.

As the ball travels forward it makes and, in a constantly decreasing degree, maintains this tube of compressed air. As this compressed air flows over the ball, if we may inversely express it in this manner, it spreads and runs between the excrescences on the ball.

The indentations thus get a grip, or take hold, of the air so that the ball is steadied in a remarkable degree during its flight and, although this is a point that has never even been raised, the suctional action in lateral rear of the ball, probably also gets greater control on account of the marking of the ball.

It will thus be seen that, in effect, the golf ball has a "tail" of compressed air wherever it flies; that this tail is of varying degrees of density from the point of utmost compression in front of the ball until it regains normal density behind the ball, and that, on account of the lateral suctional action of the "tail" its influence persists until the point of normal density is reached.

We have now to consider the phenomenon of the erratic flight of the smooth ball. This has puzzled even a scientist so eminent as Prof. J. J. Thomson, Cavendish Professor of Physics at Cambridge University, England, and winner of the Nobel Prize for Physics. Professor Thomson has admitted that he is unable to explain it, and, indeed, it is not easy to do so, but the explanation of the flight of the rough ball may help us in the consideration of that of the smooth sphere that is never used in practical golf.

The smooth ball cannot be relied on in any way. It ducks and soars and darts about sometimes almost as erratically as a butterfly. It would seem that the reason for this is, primarily, that its lack of grip prevents its "holding into its line." In other words the ball has a better chance of "slipping" its cushion of compressed air.

This probably is aided considerably by the defective center of gravity of the ball, a most common fault in most golf balls and a grave defect.

If the center of gravity of the ball is defective one side will lag more than the other and this will be seized on instantly by the compressed air to force the ball out of line. If the ball encounters, as it of course very frequently does, strata of air of varying density and also air pockets, these vagaries will be exaggerated; for the stream of compressed air is distributed thinly and, comparatively speaking, evenly over the surface of the smooth ball. It is then easier to break through than if the ball were, if we may so express it, in the grip of the "fingers" of compressed air that clutch the marked ball.

A consideration of these phenomena forces one to the conclusion that in the near future the marking of the golf ball by determinate indentations as in the ordinary "dimple" or "pit" markings will become obsolete. The bramble or pimple marking is now, if not actually obsolete, at least obsolescent, and in the opinion of many good judges it will soon be the same with all determinate markings, for they interfere with the "stream line" of compressed air and have no advantage whatever over the old marking by indeterminate grooves or sunken lines that ran right round the ball and allowed the compressed air to escape without unnecessary friction.

An American Canal Between Lakes Erie and Ontario

Projected Ship, Sanitation, and Power Canal Involving Construction of Giant Lift-Locks

Dr. J. A. L. Waddell, Consulting Engineer

FOR more than forty years there has been mooted the question of building a canal to connect the waters of Lakes Erie and Ontario on the American side of the border. As the discussion has broadened with the increase of knowledge in general engineering and in the sciences of hydraulics and sanitation, a greater scope of project has gradually been included; and at the present time there is under serious consideration a plan for building a combined ship, sanitation, and power canal, starting in Lake Erie at a point south of the head of the Niagara River, then running east to the shore and gradually turning north so as to pass behind the City of Buffalo and west of the City of Lockport, reaching Lake Ontario at the harbor of Olcott. Quite lately the U. S. Government has indicated that it would be advantageous to have a ship canal connecting those lakes.

The total length of the proposed ship canal is about forty miles, and that of the proposed tributary barge canal about twelve miles. The bottom width of the former varies from 250 to 300 feet, and that of the latter is about one hundred feet. The depth of the ship canal is to be 30 feet, and that of the barge canal 12 feet.

The total fall between the two lakes is 327 feet. Of this amount eight feet of drop could be utilized at the head of the canal so as to reverse the flow of the watercourses and the main sewers in Buffalo and Tonawanda; about seven feet would be needed to produce the required velocity of two and a half miles per hour in the canal; and the remaining height of 312 feet would be divided between two lift-locks, one of 208-foot and the other of 104-foot rise. Naturally, the canal would project into each lake for the purpose of creating a harbor and terminal docks.

As the level of the existing Erie Canal is slightly greater than that of the proposed ship canal, it would be necessary to provide locks to carry barges from the former into and out of the latter, and to syphon the water of the Erie Canal beneath the bed of the ship canal.

The object of the projected construction is three-fold, viz:

First.—To carry the largest lake-vessels, as well as barges, between Lakes Erie and Ontario in the shortest practicable time and at the least possible expense.

Second.—To divert the sewage of the cities of Lackawanna, Buffalo, Tonawanda, and contiguous municipalities from Lake Erie and the Niagara River, which sewage now seriously pollutes the drinking water of the numerous communities along the banks of the latter, and in times past has caused serious outbreaks of typhoid. After using such purifying agencies as may be found necessary, it would then be discharged into Lake Ontario so far from the shore as to render it unobnoxious.

Third.—To develop energy to the amount of about 800,000 horse-power.

According to a treaty with the Canadian Government, there can be diverted from the Niagara River, for power and sanitation purposes combined, 20,000 cubic feet of water per second; and this, it is estimated, will produce in falling the 320 feet (or the combined heights of the three locks) the 800,000 horse-power mentioned.

The two main power-houses should be located below the lift-locks and as close thereto as the configuration of the ground and the navigation requirements will permit. The utilization for power production of the eight-foot fall between the mean level of Lake Erie and the constant level of the head of the canal has been contemplated; but the economic problem which it involves will have to be technically solved before any determination of this point can be reached.

The principal promoter of the enterprise, Mr. Millard F. Bowen, of Buffalo, maintains that this will be "the only fair water-power development ever offered to the Government," and gives a number of reasons to substantiate his claim.

The main benefits to be derived from the proposed canal are the following:

First.—A ship canal, entirely on American soil and well back from the Canadian boundary line, capable of transferring the largest lake vessels from one lake to the other in a very short time and at the smallest possible expense.

Second.—A large harbor of safety at each end of the canal.

Third.—Barge canal terminals for New York State.

Fourth.—Prevention of pollution of international drinking waters.

Fifth.—Conservation of national reserve resources by the development of 800,000 horse-power two-thirds of which are now going to waste.

Sixth.—Prevention of floods in Buffalo and Tonawanda by carrying off quickly the storm waters.

Seventh.—Maintenance of a practically constant water level for Lake Erie by means of submerged weirs.

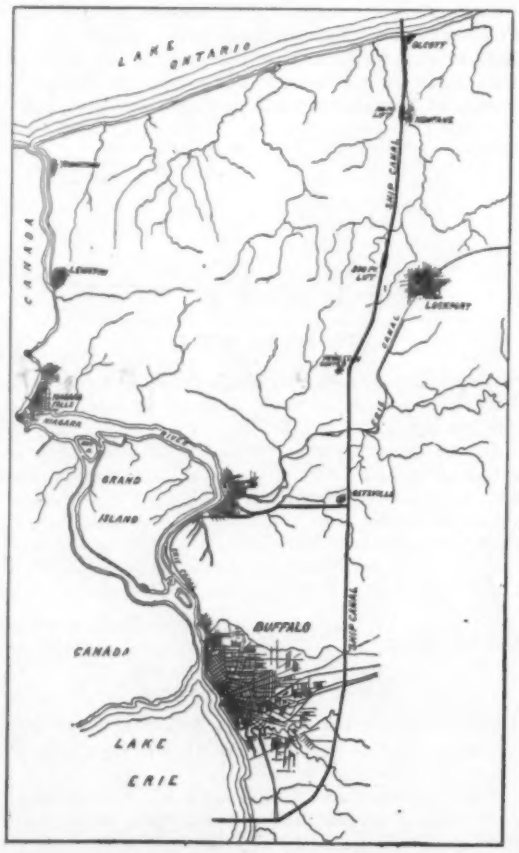
Eighth.—Maintaining the beauty and insuring the permanence of Niagara Falls by building a spreading pier at the crest of Horseshoe Falls.

Ninth.—Protection of valuable food fishes by removing pollution of the water.

No accurate estimate of cost of the entire project is possible at this time, because the necessary surveys have not been finished, and because the existing chaos in the material and labor markets renders reliable estimating on any large construction impracticable. Approximate profiles have been drawn by using the Government contour maps; much information has been collected concerning the character of the materials to be moved; and the approximate quantities of earth, shale, and rock excavation have been figured from the geological and geodetic maps in existence.

It is easily conceivable that the total cost of construction would be large; and it is probable that not less than $125,000,000 would be required to complete the entire construction and to put into operation the canals and the power development. While it is impossible today to predict with any accuracy what will be the cost of any proposed construction after the close of the war, the writer feels assured that the project under consideration will require not less than the amount just mentioned.

The most strikingly novel feature of the proposed work is the lift-locks, because these are of unprecedented



Route of the proposed canal between Lakes Erie and Ontario

dimensions, weights, and rises. The five existing lift-locks that have been built up to the present time are large enough merely to carry a single canal barge, and the depth of the water in them is not greater than twelve feet. The larger of the two now suggested is illustrated on the opposite page, from which it can be seen that each lift consists of two steel tanks. Each of these is 660 feet long by 70 feet wide (inside measurement), by 35 feet deep, so as to contain 30 feet of water without danger of spilling. The inner edges of the two tanks are connected by wire ropes running over a line of 56 sheaves, each 20 feet in diameter; and each outer edge is connected by wire ropes running over a similar line of sheaves to a row of large concrete counterweights. As the depths of water in the two tanks are to be kept equal at all times, as nearly as may be, the loads to be raised and lowered will always be counter-balanced.

The three piers or walls for supporting the sheaves are about 280 feet high, and each varies in thickness from 9 feet to 17.5 feet. They are toothed by offsets or buttresses (so as to permit the passage of the projecting steel hangers) on both faces of the middle wall and on the inner faces of the two outer walls; but, on the outer faces of the latter, one-half of the offsets are omitted, so as to provide room for the large counterweight blocks. The dimensions of each of the latter in plan are 18 feet by 10 feet; and the height would be about fifty feet if iron ore be used in the concrete, or considerably more, if not. Whether the ore is employed to increase the specific gravity will involve later the solution of an economic engineering problem. There are 28 of these counterweights carried by each of the outer walls.

At each end of each tank there is provided a steel gate operating vertically and dropping into a steel box which contains water; and two similar gates are to be located at the high end and two more at the low end of the canal. The weights of metal in these gates and their receiving boxes have been roughly estimated upon a fairly liberal basis; but the complete, complicated details therefor, of course, have not yet been designed. Those for the remainder of the tanks and for the operating machinery, however, have been computed with some accuracy.

The operation of the lifts would be by electricity, generated in the large power-houses located in their vicinity, the water therefore being carried from head-race to tail-race through large pipes or tunnels. The power would be applied to the rims of all the sheaves by means of racks and pinions, with reduction gear leading to the motors. These are to be placed on top of the piers, each of the latter being capped by a large concrete slab, thus forming a platform some 23 feet wide and 680 feet long. All the motors are to be so connected as to act strictly in unison, in order that the upward and the downward motions of the tanks may be regular and uniform.

Beneath the tanks there are to be large air-buffers, capable of bringing the tank to rest from its greatest-allowed speed; besides which there would be self-acting solenoid brakes to check the velocity at the proper places.

Locking apparatus would be required to hold the tanks to exact position at top and bottom of travel. These would project through the walls or piers; and they would have to be of a most substantial character.

Provision must necessarily be made to take care of the effect of the stretching of the wire ropes under load and operation, the amount thereof being about one per cent of their total length.

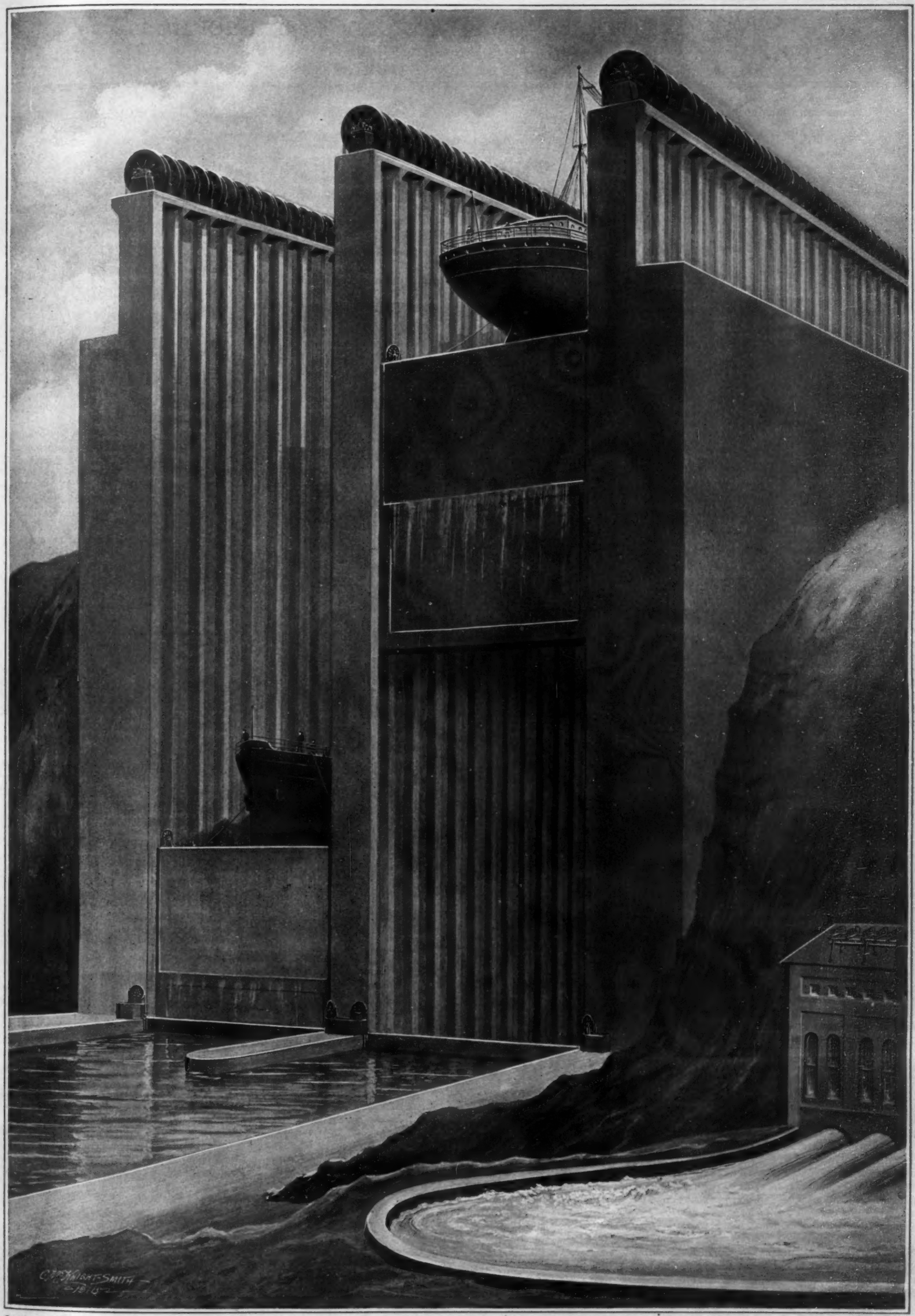
Some conception may be formed of the magnitude of these lift-locks by an inspection of the following partial list of the estimated quantities of materials required for the construction of the higher one, as computed by the writer, who has been retained by the promoters to prepare the plans and estimates of cost therefor.

Metal in two tanks, excluding gates	26,000,000 lbs.
Socket attachments for same	3,560,000 lbs.
Wire ropes	6,980,000 lbs.
Rope sockets	840,000 lbs.
Sheaves and bearings therefor	16,850,000 lbs.
Sheave supports	1,650,000 lbs.
Cast-iron balancing chains and details	5,920,000 lbs.
Pneumatic buffers	600,000 lbs.
Steel in counterweights	3,000,000 lbs.
Total metal, excluding machinery and gates	75,400,000 lbs.
Concrete in walls	236,700 cu. yds.
Concrete in counterweights	18,400 cu. yds.
Value of operating machinery, motors, pumping plant, gates, houses, cranes and tracks	$1,156,000

Between the gates of the canal and the adjacent gates of the tanks there would necessarily be spaces that must be made as small as possible, because the water which at times fills them has to be wasted. That water at the higher level would be caught in small reservoirs located at the sides of the cutting a little below the elevation of the highest level of the bottoms of the tanks; and from there it would be pumped back into the head-race, so that only a small proportion of its maximum possible energy would be lost. But the corresponding water at the gates in the tail-race would fall into the sump of the pit; and from there it would have to be pumped out, so as to maintain the said pit free from water. The pumping machinery for keeping the pit dry would have to be capable not only of taking out the water wasted at the lower gates but also the greatest amount of rainfall that could reach the said pit—and as rapidly as it can enter. It is, therefore, important that the watershed be reduced to an absolute minimum by the construction of effective slope-drains. The average height of the bottom of the pit would be about 60 feet below the surface of the water in the tail-race; and the elevation of the bottom of the sump would be some 25 feet lower than that of the lowest portion of the pit.

The higher lift-lock would require about ten minutes to raise, and the lower one about five minutes; and it would take several minutes more to raise and lower the gates. Possibly a passage through the higher lift could be made in as short a time as 20 minutes, and through the lower lift in 15 minutes. As it takes several hours for

(Concluded on page 263)



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Lifting ocean liners up to Lake Erie. Proposed 200-foot lift-locks capable of handling 650-foot ships of 30-foot draft

World Markets for American Manufactures

Conducted by WILLIAM W. SNIFFIN

A department devoted to the extension of American trade in foreign lands

American Machinery in Japan

By Adachi Kinnosuke

The following article is interesting as expressing an Oriental's attitude regarding American participation in the trade of the Far East. The writer appears not to realize the enormous demands placed on the American manufacturer by both war needs and the increased domestic needs of this country. He appears not to understand the viewpoint of the American manufacturer, who has, in many cases, more orders than he can possibly fill at the present time, particularly if the order is for special makes. In the present situation the attitude of the American manufacturer is merely in conformance with the economic law of supply and demand. While we do not indorse Mr. Kinnosuke's criticism we believe that the readers of the SCIENTIFIC AMERICAN would be interested in the ideas of a foreigner, and especially those of an Oriental, regarding our opportunities for establishing new trade connections.—EDITOR.

AMERICA can sell her machinery to Japan. She has done so—the photographs accompanying this article offer proof of this fact. Moreover, she is not selling one-hundredth of what she should sell. What is needed naturally is to visualize this thing—this minus sign in America's trade activity in Japan; and to make the American manufacturers of various kinds of machinery feel and realize it.

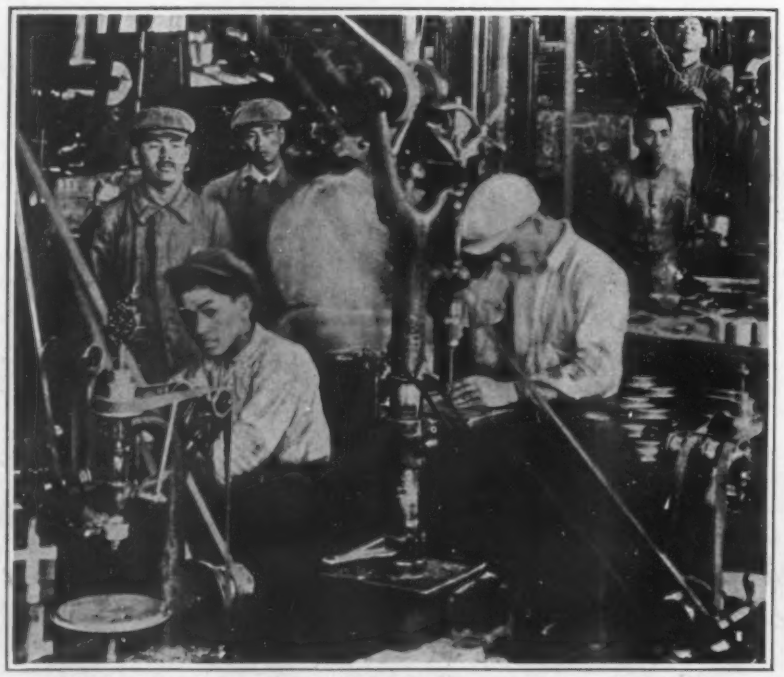
And now is the accepted time. The world war has practically forced the American manufacturer in this particular line to stand and deliver, so to speak. Before the war, in 1913, America sold to Japan about twenty per cent of the machinery of various types that Japan bought abroad. England sold her more than any other country—50 per cent of all the machinery that she imported that year. Up to that time, the American manufacturer of machinery had not exceeded England in his sales to Japan or even come within a competing distance of the British. Two years after the war began—in 1916—there was quite another story. In that year Japan spent 16,000,000 yen (a little more than $8,000,000 in American money according to the present rate of exchange) for her imports of machinery. British manufacturers received 7,000,000 yen of this sum. That is much less than they should have had, and the world war was blamed for it. There was, however, nothing at all sensational about the amount of England's share. What was sensational—scandalous in the eyes of some of the European makers and exporters of machinery to Japan—was the share of American manufacturers that year. They exported 7,780,000 yen worth of the total of Japan's imports of machinery. In that, they did what is very dear to the American imagination; they absolutely broke all the previous records. They beat the British for the first time in this particular trade. Not that it was their fault that they did it—oh, far from it! The world war played a sort of hold-up man and made them sell. In fact they did not sell; the Japanese bought. They had to buy because the war practically closed the British and European markets. American manufacturers did not wish to sell, but the Japanese made them sell.

The American manufacturer sits in his sumptuous office at Chicago or New York. A Japanese customer comes to him. After a number of profound kotows before the lordly business prince, the heathen makes his petition humbly enough. He wants to buy American-made machinery to fit up his glass factory in Japan. "Sit down," says the American manufacturer, graciously. "I don't know whether we can give you what you want. We are pretty busy here just now, you know. But if we have any of that kind of machinery in stock, why, we shall be very glad to do what we can for you—very glad indeed to help you out."

The Japanese customer had not thought that he was applying for a favor or for charity. He was never trained to look upon a customer as a charity patient or even as a poor relation. His business training at home had been wrong. He is taken aback a little. But necessity is a great slave driver. The vision of his new factory in Tokyo standing bare of machinery, with the interest charges on the investment going right along drives him on. So the heathen persists in his blind obstinacy.

"What?" the American manufacturer deigns to remark, "make the machines for you specially? Well, we would like to; we always try to accommodate our customers. But really, that is entirely out of the question at the present time."

Interior of a glass-factory in Japan. The automatic bulb-blowing machine at the right was made in America



Machine shop of the Tokyo Electric Company completely equipped with American machinery

Put a European manufacturer or exporter beside the lordly American business prince. The contrast is rather impressive. A European manufacturer does not sit comfortably back in his chair in Manchester or Hamburg. He sends his representative out to Japan. But that is not all. He opens a shop at Tokyo where he can display samples of his wares. He does not stop there, either. He has his representative call upon his prospective customers. This representative patiently gathers priceless data on the peculiar conditions—business, climatic and economic—under which his Japanese customers are conducting their business. The European exporter goes further than that. He sends a number of young men—alert, ambitious and fond of seeing the world, and whose tongues have not been ossified—out to Japan. They enter his branch office there and mingle with the Japanese people. They are there to master the language as well as to learn the trade conditions and methods of the Japanese. When they ripen in years and experience, they can face their Japanese customers and talk business with understanding. Do the American manufacturers of machinery do these things? A few, yes; but mighty few.

We Japanese are supposed to know a good deal of China and the Chinese. We are right there in the Far East. We have had a common civilization and common traditions. The life conditions are not so different in the two countries. Yet, there is at Shanghai a rather extensive school established for no other reason than that the young Japanese—the future salesmen of Japanese goods in China—may study and master the Chinese language and dialects. Have the Americans established such a school for their future salesmen in the Far East? If so, they have not advertised it very widely.

After-dinner speeches at many banquets of various chambers of commerce and other commercial bodies in the United States have been quite eloquent of the American conquest of the Far Eastern trade. As an example of the world-wide advertised American sense of humor, these commercial orations are very effective. For, indeed there can hardly be anything much more choice than some of those eloquent orations as masterpieces of unconscious humor. But considered as a sober discussion of the foreign business that the United States should have and hold, there seems to be something the matter with them. When some of the orators try to blame the keen Japanese competition out there for the apparent failure of American goods to make their way more successfully, why, that is insulting the intelligence of nobody but America.

The world war has practically placed America's European competitors out of the field—especially in such things as highly specialized machinery. America has the open field now. She has a good chance to make a good start in the Far East. If she ever means to cover that field, she has very little time to lose. The foundation should be laid at once, and it is no child's play, either. Out there, she will have to face the competition of all the world in the end and prove that she is their master or at least their peer in such fields as she chooses to occupy.

The first battle that America will be called upon to fight for this trade supremacy will be fought right here at home, in the United States. It is against the nation-wide indifference in almost all foreign events and things. Before a nation can really become a world merchant, its young men must first dream of the world's market places. No amount of arguments and theories can get around this point.

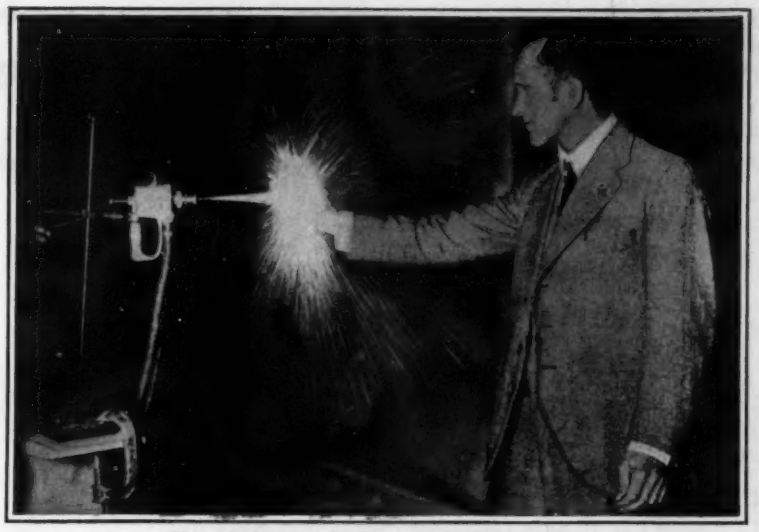
Take the case of the sale of American-made machinery to Japan in 1916, as mentioned above. It was quite an event but American newspapers did not make any particular mention of it. There may have been five hundred persons out of more than one hundred millions of wide-awake Americans who have heard about it, but I rather doubt it. The fact is, one of the most exasperating things about the tremendously and persistently advertised American enterprise and push is their utter indifference when it comes down to international trade. There are reasons for it to be sure—mighty good reasons. Why should the American manufacturer go 6,000 miles from home to sell his goods when he can get better prices for his wares at the very back door of his factory? But is that sort of blessed state of things to go on forever? One thing for which American business men congratulate themselves is their keenness of vision. Strange, isn't it, that the one outstanding characteristic of theirs is their persistent blindness in matters of foreign business?

The Cold Metal Spray, a Striking Photograph

WE described in these columns some time ago the Schoop metal spraying process, whereby a coating of metal is applied to a flat surface by being shot from a pistol in the form of a dense spray of minute particles. The outstanding feature of the process is that the metal is not applied hot, as one would naturally infer to be the case, but is cold when it strikes the surface upon which it is to be deposited.

The Swiss inventor sends us a photograph of the spray in action which brings this out in startling fashion. As Mr. Schoop points out, his process consists really in dusting a surface with iron dust and the only inconvenience which the gentleman in the picture suffers is that he will have to chip the thin coating of armor off his hand at the conclusion of the demonstration.

It may be remarked here that Mr. Schoop has recently received the John Scott Legacy Medal from the city of Philadelphia, acting on the recommendation of the Franklin Institute, as a reward for the services rendered by his invention.



The metal spray; it shoots cool metal, not hot

A New Cycle in Motion-Picture Projection

IT is a curious anomaly that in the motion-picture projecting machine business, the usual rule of supply and demand does not hold good. One may buy anything else, a watch, an automobile, a house, paying as much or as little as one chooses, getting increased value with increased cost, but for a motion-picture projector one pays about the same price for all makes. There is not today a picture equipment comparable with the magnificence of a great many of the theaters already built and many more projected.

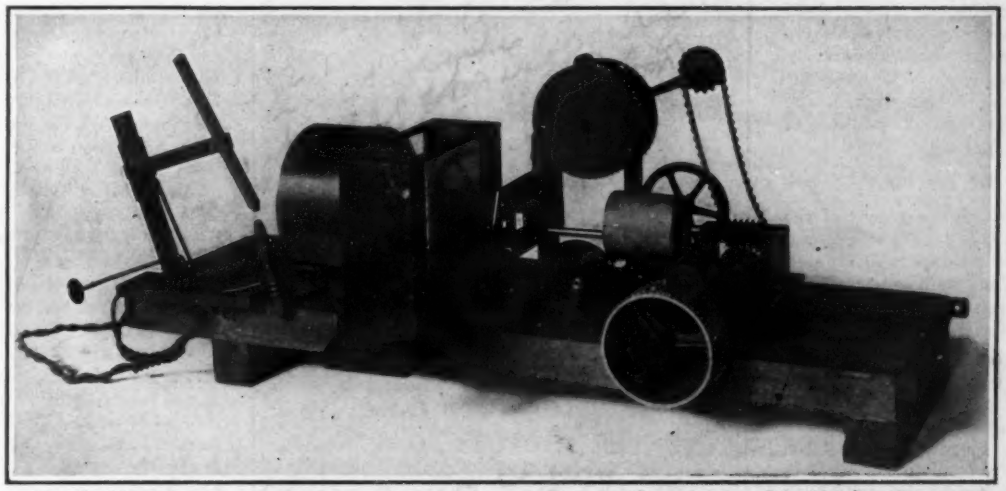
No matter how much the builder of a fine theater, may desire a correspondingly fine picture equipment, he can't get it: it doesn't exist; the only machine available is the same cheap-priced, old-type machine used in the little 5-cent "movie" house.

The theater owner may pay as much or as little as he likes for music, and other accessories, but when it comes to the picture machine, that which produces the thing he sells to the public, he is limited to a very small choice, a choice in name mostly, for the three or four machines available all sell for about the same price.

The automobile industry is nearly the same size as the motion-picture industry, but the former has above three hundred machine manufacturers, while the latter has but three or four.

The reason for this is that the old style longitudinal projector has inherent limitations, and has been developed just about as far as it is possible to go. For added cost one gets more cast iron only, the quality of the picture on the screen is not improved.

It is not so much that the old style of machine is not good; it is good, just as the steam locomotive is good, but subway and tunnel train service was impossible until a new type of motive power had been developed. This is exactly the situation in the motion-picture business. The engineer has gone as far with the old type of projector as it is possible to go—and a new type is necessary if development is to be made to meet modern conditions, greater commercial usefulness, wider educational value, and, particularly, equipment more acceptable in the splendid theaters already constructed and those projected.



The Jenkins Phantoscope, the first motion-picture projecting machine of the model which has become standard the world over. Placed in the U. S. National Museum twenty-two years ago.

Pondering this matter, Mr. C. Francis Jenkins of Washington, D. C., decided to try for this new type of machine. The result of his efforts, and that of his engineering staff, is a machine the most striking feature of which is its lateral projection. This machine is remarkable in three principal features, *i. e.*, (1) beauty of screen picture; (2) simplicity of design; and (3) absolute safety.

The making of a successful projector is not an easy accomplishment, although it is well known among engineers in the art that there are but two or three really essential elements in the projecting machine which have to do with the quality of the picture on the screen. With these carefully designed and perfectly made, the real problem then consists in the construction of the whole on lines permitting development by avoiding the limitations inherent in the present type machine.

These essentials in their simplest form, were embodied in the new type, and this machine has now been in use for more than a year, under a variety of conditions; for example, in the finest high school in the world (Central High, Washington), projecting 125 feet on an 18-foot screen, the auditorium seating 2,000 students; in private homes where safety is the essential feature; in eleemosynary and correctional institutions, battleships, and so on.

The essentials having thus been given a thorough test, the next step was the design of a duplex model for use in the finer theaters, a machine embodying a right and left machine construction in a single unit, and with the right and left elements of this duplex construction electrically crossed so that one machine controls the starting and stopping of the other, in such a manner that the show is continuous on the screen without any attention from the engineer in attendance whose only duty is to stand by and see that everything goes smoothly just exactly as the engineer in an electric light station does to day.

To this lateral projection and duplex construction is added a panel board on which meters are mounted for electrical current measurement, speed and light values, and also a pilot picture upon which the engineer watches the framing. The engineer in charge learns, in a glance at the panel board, the running condition of every integral part of his installation as well as the state of the picture on the screen. For the board is equipped with every modern device to show ampere flow and voltage, of both the main line and the generator sets, speed of the film through the machine in feet per minute, and the duration of the reels in time. A duplicate of this direct-reading board is in the manager's office, and the manager's office and projection room are also telephonically connected; a speedometer is also located in front of the orchestra leader for his own guidance.

When the patron of a duplex projector equipped theater enters the auditorium, he sees just in front of him, under the first balcony, a platform some three feet above the main floor. This platform has a brass railing, and brass steps leading up thereto. In the center and at the forward edge of this brass-railed carpeted platform is a

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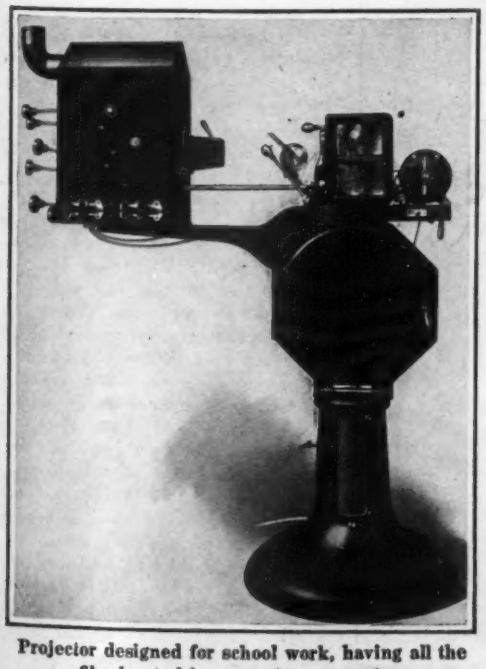
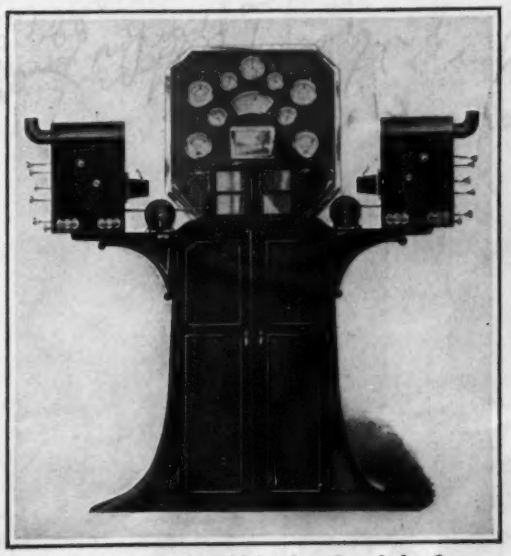
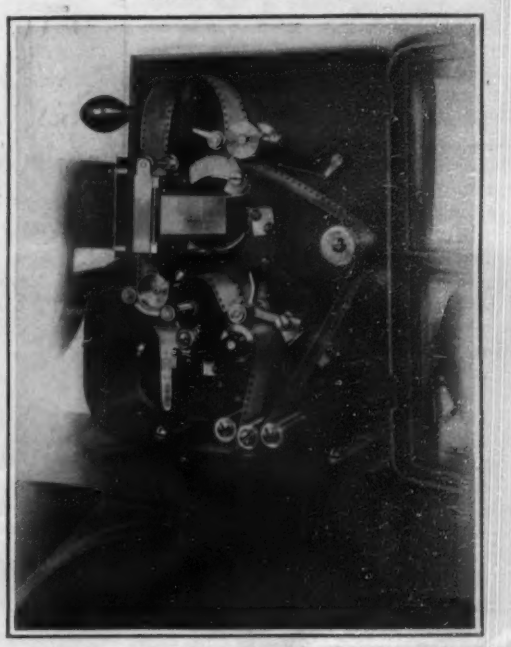


Projector designed for school work, having all the film located in a cast-iron magazine



A duplex projector which takes the whole of a six-reel show at one loading



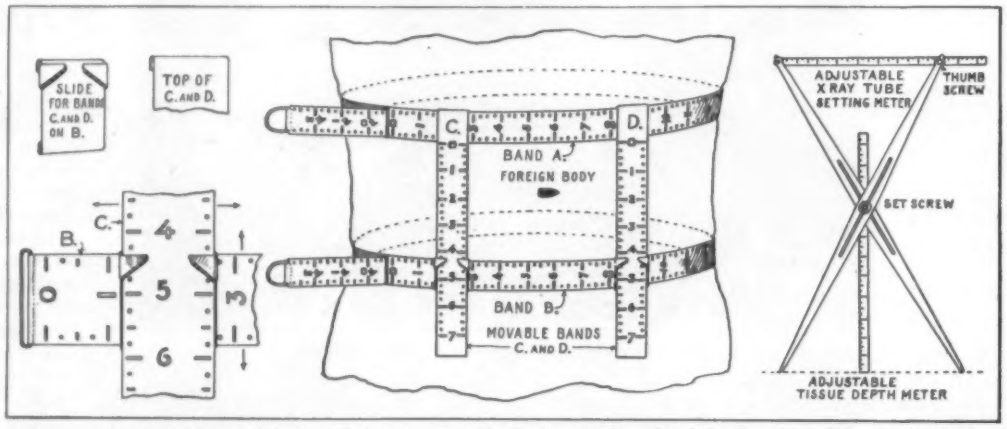
Close-up view of the mechanism of the new projector, showing the threading of the film

Inventions New and Interesting

A Department Devoted to Pioneer Work in the Arts

An X-Ray Tape Measure

SOMETHING a little bit different from the usual run of devices for X-ray location of foreign bodies has been suggested by an officer of the Medical Reserve Corps. The novelty consists in the means taken for overcoming the fundamental deficiency of the shadowgraph—namely, that it conveys no information about distances. It is proposed to place about the patient's trunk or limb, as the case may be, a flexible metallic tape measure, as illustrated, the calibrations and the numerals marking them being perforated in the metal. These calibrations will, of course, then register on the shadowgraph, lending a very obvious aid to the mathematical work of measuring the depth of the intruding body.


SLIDE FOR BANDS C. AND D. ON B.
TOP OF C. AND D.
B.
C.
BAND A. FOREIGN BODY
BAND B. MOVABLE BANDS C. AND D.
ADJUSTABLE X RAY TUBE SETTING METER
THUMB SCREW
SET SCREW
ADJUSTABLE TISSUE DEPTH METER

The markings on this metallic tape, being perforated, shadowgraph and aid the location of the foreign body

The designer has paid a good deal of attention to the mechanical details, as our drawing indicates. He suggests that the bands be illuminated with radium paint for working in the dark room and for adjustment in the dark at the hands of the fluoroscope operator. He points out that the bands, when anchored in place by adhesive tape, may be left on any part of the body for any length of time. When this is not desired, the calibrations may be marked on the patient by nitrate of silver or luminous paint.

A Novel Tread for the Tractor

AMONG the many mechanical developments of the war which have been profitably turned to peaceful industries is the pad wheel for tractors which we illustrate. It is an Italian creation, designed to fill the need of military tractors in the rugged and mountainous country of Italy at the time of their entrance into the war.

The inventors are Messrs. Pavesi and Tolloti, engineers at one time with a large automobile company at Turin, later manufacturing power-operated plowing outfits in their own plant at Milan. Foreseeing the opportunity for adapting this to development work in this country and Canada, M. Leoni, also an Italian engineer and personal friend of Pavesi and Tolloti, secured the patent rights in America and organized a company to market the device here.

This pad wheel differs from other pad types in that the pads are not pivoted in the wheel rim, but are simply held against it by means of springs. This permits the wheel rim to roll over the track on the pads without causing the pad to mill or scrape the soil, and by virtue of this the wheel can go over macadam and asphalt roads without injury to their surfaces. Each pad offers a reaction surface that is thrust against a corresponding roller in the wheel rim, and since these reaction surfaces reproduce exactly the involute curve described by their rollers in their cycloidal movement during the rotation of the wheel, it naturally follows that between the reaction surfaces of the pads and the rollers there is merely a rolling movement, and consequently a minimum of wear.

Working experiments have proved that this type of wheel has so much greater efficiency over the conventional friction wheels that a tractor on a hard road can develop its own weight at the drawbar, which on ordinary fields increases the efficiency of a tractor from thirty to fifty per cent. This increased efficiency in comparison with the conventional type of wheel is particularly desirable in farm tractor design, for in operating at very low speeds a great gear reduction is essential and obviously a drive wheel of moderate diameter is preferable. At the same time this permits a low, compact construction; and by keeping the tractor center of gravity low a much narrower tread can be employed than in the case of tractors of high center of gravity.

The pad wheel that gives great flexibility of service

What a Little Inquisitiveness Did for the Violin

"THE violin is the only perfect musical instrument and has not been materially changed in its construction or form for a period of over 350 years," read Mr. Frank M. Ashley of New York city in one of the scientific journals some years ago. But this inventor is of that type which takes nothing for granted. He was curious to test the truth of that statement. So he set to work on an old fiddle in order to learn the secret of tone in the violin, as well as the possibilities of structural improvement. The result has been a new method of constructing violins, and, it appears, the solving of the tone problem.

The sound box of a violin has hitherto been constructed with an arched top or belly, an arched bottom or back, and sides or walls of substantially uniform height between the two. The arching of the belly and back is primarily for the purpose of taking up the strain exerted by the downward pressure of the bridge caused by the tension of the strings, as the arched construction stands up much better and resists distortion to better advantage than a flat construction.

To secure this arching, it has hitherto been necessary to take a slab several times the thickness of the finished belly or back and rout the piece according to carefully laid out diagrams until the proper proportions have been obtained. This process is wasteful in material and involves considerable time and labor of a skilled workman. Moreover, after the instrument is completed, it takes a long time for it to develop its proper tone.

In the routing process a large number of the long straight wood fibers are cut across and removed and the remaining short fibers do not transmit the vibrations as freely as the long unbroken fibers, so that it requires a longer period of time to render the fibers elastic in the act of playing. Age alone will not render a violin beautiful in tone; in fact, age alone makes the tone weaker as well as the instrument. But an instrument that has been played upon for years becomes more mellow and brilliant in tone and responsiveness due to the fibers becoming more free and elastic.

The ordinary instrument thus requires many years to attain its responsiveness and mellow quality of tone. It has long been recognized that the lowest arched instruments of the Stradivarius type are much more powerful, brilliant and responsive than higher arched instruments of the early German type. The reason for this is two-fold: first, that the flatter instruments have fewer of the fibers cut in the belly and back, and, furthermore, the flatter instrument permits a freer vibration as is evident from the general physical law governing vibrating plates.

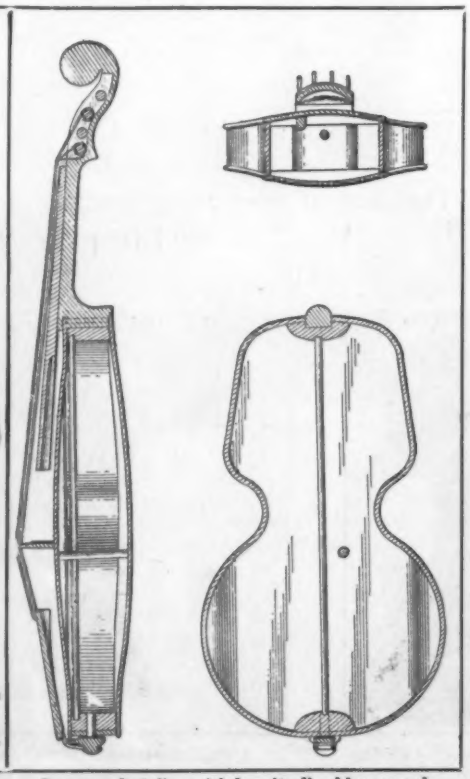
To avoid the expense involved in routing the instrument, resort has hitherto been made to pressing the parts in form by steaming the wood and subjecting the same to pressure in a mold or die. This steaming and pressing process, however, crushes the fibers and destroys their resonant qualities, and thus the instrument produced by this process has very inferior tone qualities and does not answer the requirements of the musician.

Having learned all of the foregoing facts from his investigation, Mr. Ashley set to work applying his newly-acquired information. He has developed an instrument which he claims possesses all the superior tone qualities of the old instruments of the Stradivarius and Guarnerius types, with the additional advantage consisting in the attainment of the mellow quality of tone and responsiveness of the instrument in a much shorter time. These advantages are obtained by making the belly and back of the instrument of flat pieces of wood which are bent longitudinally or transversely, or both longitudinally and transversely to form the required arch and this arch is maintained by a corresponding arched formation of the sides and ends. Thus the required arching is secured without routing and with a minimum cutting across the length of the fibers.

In making the top and bottom plates of his violin, Mr. Ashley takes the wood in the form of a thin board, having long fibers, cut to the required

(Concluded on page 263)

Three views of an improved type of violin



Improved violin, with longitudinal brace rod

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Our First Year of War

TWELVE months ago, the United States entered into the great struggle for democracy. It has been a year teeming with activity. Untrained in the arts of war, we have been obliged to wrench our thoughts out of the path of peace and turn them into new and unaccustomed courses. Appreciating the enormity of the task before us, we have thrown into the fray our rich resources in men, money and materials. Public attention has been so absorbed with criticism and investigation, so much light has been focused on deficiencies and blunders, that we have almost lost sight of the really great things that have been done.

Now that we have come to an important milestone of the war it is fitting that we should stop and reflect on the events of the past twelve months. It is an inspiring review. We have made colossal preparations; we are going to accomplish a great work.

In a special number of the SCIENTIFIC AMERICAN dated April 6th, 1918, the accomplishments of our first year of war are reviewed. We have gone to the highest sources for information. The articles in this number are written by cabinet officers and department heads.

The Hon. Newton D. Baker, Secretary of War, has contributed an article telling how our Army has grown from a comparatively insignificant force (according to present day standards) to over 1,500,000 men. The article explains how we are cooperating with our Allies and how their wishes have influenced the development of our Army.

Drawn by Gerrit A. Beneker — Cover Illustration

The fight for Liberty

The Hon. Josephus Daniels, Secretary of the Navy, tells of the splendid work of our naval forces. "Always on its toes" this branch of the service was ready to render immediate aid in the fight against the submarine, and its maintenance of transportation across the sea has been invaluable.

No less important is the work of the Director General of Railroads. Without efficient transportation facilities at home we cannot attempt to keep our Armies supplied in the field. Heroic efforts have been made to relieve the congestion of our railroads and transport the enormous accumulations of war materials.

For every man in the trenches there must be at least five men at home, working to supply him with the munitions of war. The labor situation is a highly important factor in the struggle and this is covered in an article by the *Hon. W. B. Wilson,* Secretary of Labor.

"The Fight for Public Opinion" is told by *Mr. George Creel,* Chairman of the Committee on Public Information. It emphasizes the fact that Germany is waging as intense a psychological fight behind the lines as she is a military fight at the front.

A special article has been prepared by the United States Food Administration, and *Dr. Harry A. Garfield* has written on the fuel situation.

One of the most valuable outcomes of the war will be the upbuilding of an American merchant marine, while the present necessity of constructing ships is of utmost importance. Naturally, great public interest is centered in the work of the Shipping Board. The story of this work is told in a special article prepared by *Mr. E. N. Hurley,* of the Shipping Board.

The general public does not realize what a debt it owes to the work of the Council of National Defense. The services of the Advisory Board of this Council have been given without charge, from purely patriotic motives. Millions and even billions of dollars have been saved to the country by the advice of the Board. An account of its work, which we believe is the most comprehensive yet written, has been prepared by *Mr. Grosvenor B. Clarkson.*

The important subject of motor transport will be covered by *Mr. H. L. Horning,* chief of the Automotive Section of the Council of National Defense.

The public has but little conception of the vast motor fleet that has been prepared for service behind our battle front.

The number opens with a specially prepared editorial by *Senator James Hamilton Lewis.*

The news companies will be supplied with an extra quantity of this number—it should be on sale everywhere—but to insure getting it, order now.

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The Telephone in Khaki

(Concluded from page 252)

Western front. Sometimes the enemy's line is physically tapped; that is to say, under cover of darkness a scout from the other side succeeds in "cutting in" on the telephone system. Again, it may be the work of a spy; as likely as not, there are many instances in this war in which the enemy has been "cut in" on important telephone lines by spies working back of the lines. But the usual method to tap a line is by inductive means. In this case wires laid parallel to those of the enemy permit one to intercept the magnetic leakage from wires some distance away, and by means of sensitive apparatus this electrical method of tapping is often quite effective.

There is no telling when the enemy may be tapping a telephone line. Hence telephone conversations, if of an important nature, are generally carried on in code, with mysterious numbers and letters for indicating various batteries and regiments and positions. The secrecy of the telephone, which is too often taken for granted, no longer exists on the fighting fronts. For it is quite obvious that the enemy will stop at nothing to interfere with or to gather the information which is passing over hostile lines.

What little has been permitted to filter through the censor with regard to our military telephone system in France, indicates that we have set a mark in this branch of military activity. Over twelve thousand competent operators have been organized into a special force to handle government messages throughout the nation. Also the organization of the army under General Pershing is linked by telephone all the way from the port of embarkation to the foremost line of trenches.

An American Canal Between Lakes Erie and Ontario

(Concluded from page 256)

a vessel to pass through the combined locks of the Welland Canal, it is evident that the aggregate total saving in time of transit would be enormous. Again, the amount of energy required to operate the lift-locks is very small in comparison with that of the total wasted energy of the water spent in passing vessels through the locks of the Welland Canal. At present this is a matter of no importance, because the water-power of Niagara River is but partially harnessed; but the time is coming when practically all of its energy will be utilized, and then the uneconomies of operating the Welland Canal will be more generally appreciated.

As the proposed canal would have to take care of all the storm waters reaching the territory through which it passes, it is evident that some means of controlling the amount of water entering at Lake Erie would be required. The method of doing this is simple, and the cost involved is small. Submerged weirs placed in the Niagara River near the International Bridge would regulate and maintain lake level.

The project would probably involve the building of a spreading-pier above Horseshoe Falls so as to distribute more uniformly the flow of water over the crest and thus check the steady cutting away of the rock face and the consequent retrocession of the falls; although, strictly speaking, such work should be undertaken jointly by the American and the Canadian Governments. In truth, it is a public work that should have been done many years ago.

This project is a great and important one; and, in all probability, it will ultimately be materialized—and the sooner the better in so far as the welfare of this country is concerned.

A New Cycle in the Motion-Picture

(Concluded from page 259)

bevel plate glass enclosed room in which two duplex projectors are installed. One of these is in service projecting a picture, while the other is held in reserve, for the same reason that two complete electrical equipments are provided in every power house. The engineer in charge of this installation is dressed in a Tuxedo coat, in keeping with the dignity of the equipment itself.

The purpose of the Brussels carpeted brass-rail platform with the brass steps leading thereto, is to enable the patrons of the theater to see the "wheels go round," just as the engine room of a transatlantic liner is one of the show places aboard the ship.

One can well imagine that the handsomely gowned ladies and the dress-suited gentlemen add to the splendor of the setting, and that for months after the opening of such an equipped theater, it will be the most talked of in the city, and enjoy a correspondingly, high-class, high priced, capacity patronage.

Mr. Jenkins, by the way, is the inventor of the old type machine in universal use, the original of which was placed in the United States National Museum some twenty-two years ago, where it remains to this day, on exhibition in the Graphic Arts Department. He stands alone in having received honorary recognition by scientific societies for research in this art. Mr. Jenkins' ability is also recognized in the industry as is evidenced by his unanimous election as president of the Society of Motion-Picture Engineers.

It will be remembered by some that the first steam engine employed a boy operator to manipulate the crank which shifted the entering steam from one end to the other end of the cylinder of the engine. But this hand operation only continued for a few weeks before the boy fixed it so that the engine automatically shifted the slide valve.

It is not particularly creditable to the engineers in the motion-picture business that we are only just beginning to think of an advance over the crank-turning stage in the motion-picture projecting machine, although until a new type was invented further development was impossible by reason of the limits of the old type of machine.

What a Little Inquisitiveness Did for the Violin

(Concluded from page 260)

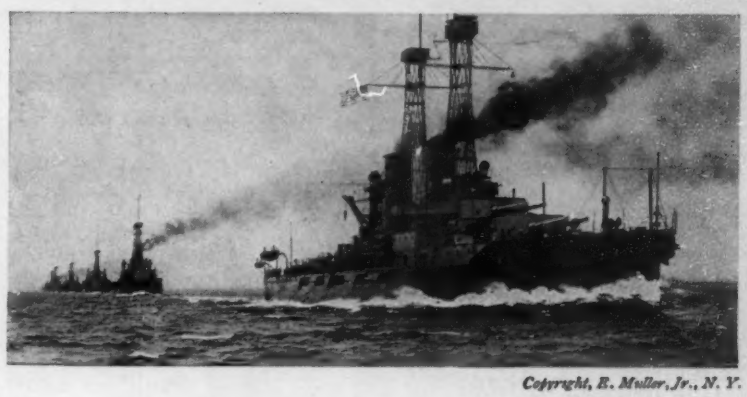
outline, and places them in a press on a form to bend the wood into an oval shape at the waist portion, being careful not to press fast or far enough to rupture or injure the fiber of the wood. After a few hours in the press, the plate may be removed and will remain permanently set; then the plate is simply bent over the curved edges of the side and end walls and glued thereto in the usual way. In this manner, states the inventor, he is able to provide a construction of beautiful appearance, while retaining the strong, long fibers.

If the pressing operation is used to form a high arch without the side- or end-walls being raised or curved at the waist as shown in the accompanying side view of the new violin, the fibers are strained and ruptured and the tone of such an instrument will never be satisfactory, according to Mr. Ashley.

The new violin is made in various models, with the old outline and with a new outline in which the form is changed in the upper part in order to allow the player to reach the strings easier when playing in the high positions, and also to bring the widest part of the breast of the instrument nearer to the bridge, thereby increasing the power of the instrument. In the new outline instrument the sides are each formed of a single piece and no corner blocks are used.

Instead of using corner blocks to resist the strain caused by the tension of the strings, a brace-rod is used which extends from the top to the bottom block, just below the top plate. This brace-rod prevents excessive buckling or compressive strains on the top and permits it to be vibrated more freely, thus further tending to make the instrument responsive and free in tone, while removing to a great extent the strains from the side walls caused by the tension of the strings.

And all this due to a doubt aroused in the mind of Mr. Ashley, as he was reading about violins!



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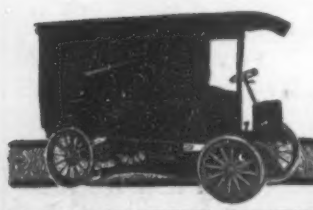

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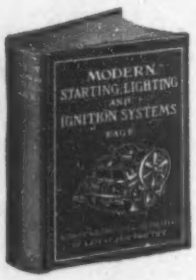

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Rare Earths and What We Can Do With Them

THE term earth is applied to certain metallic oxides which were formerly looked upon as elementary, and names ending in *a* are ordinarily used to distinguish them from the elements concerned, which are designated by the suffix *um*. The rare-earth elements are cerium, yttrium, lanthanum, neodymium, praseodymium, scandium, dysprosium, europium, samarium, terbium, ytterbium, lutecium, celtium, erbium, holmium, and thulium. Of course the elementary rights of certain of these are still under adjudication by the chemical courts of last resort; and a number of additional names, such as victorium and decipium, have been proposed for what the authors believed to be additional elements. The chemistry of all these substances is extremely difficult, and the status of many of them will be in doubt for an indefinite period.

At present only a few of these rare earths find any practical use. Industrial chemistry is making such immense strides, however, that it is well to be prepared to welcome any or all of them into the arts at a moment's notice, even though at present they seem to be strictly chemical curiosities.

Cerium is found in many minerals, the most abundant of which are monazite, allanite and cerite. When the industrial uses of cerium were discovered a demand for allanite rose, and a large deposit was found in Virginia. Monazite, however, is much more abundant than all other sources combined, thousands of tons being mined annually for the thorium content which is the basis of incandescent gas mantles. Since about a quarter of this ore consists of ceria, the total quantity of cerium consumed is at present but a fraction of that produced; and it is accordingly strictly a by-product.

The incandescent mantles of best composition contain about one per cent of cerium, and perhaps this is the most important application. Then, too, the metals of this group throw off glowing sparks when scratched; and the igniting properties of these has been applied in cigarette lighters and a variety of gas lighters. Their use has also been suggested for the ignition of explosives and as a photographic flash producer. In certain dye and acid making processes cerium salts are employed as catalysts; the sulfate removes the silver from over-developed negatives; other salts are employed in color photography; the oxylate finds application in medicine; and attempts have been made to utilize cerium salts in tanning, dyeing, and the manufacture of enamels, porcelains and glasses.

The chief sources of yttrium are the minerals gadolinite and xenotine, together with the tailings from the thorium mine, after the extraction of the throium from monazite. The minute quantities in which these rare earths are sometimes mined and used is well illustrated by the statement that the largest American deposit, in Texas, has to date turned out no less than one whole ton of ore! Yttrium has been used in the Nernst lamp, but has been supplanted. It is a catalyzer in some processes; but the present demand is insignificant.

Other extracts from the monazite tailings are lanthanum, neodymium and praseodymium. Like most other rare earths, there is really no dearth of these; no less than two hundred different minerals which contain them in more or less microscopic quantities are listed. A solution of the nitrates of these elements is used for marking the gas mantles, and, under the action of the heat, changes from a very faint hue to the deeply colored and permanent hue of the oxide. On the whole it seems that it is the only gas mantle which makes it worth while to dig any of these rare earths out of the ground and refine them; although of course there is always the presumption that some bright young man may bob up with further uses for them. For the present, demand certainly is not up to visible supply; so we would hardly urge indigent land-owners to mortgage the old homestead for funds with which to dig these jaw-breaking substances.

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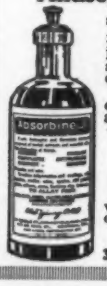

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Zirconium—A Resumé

IN its large publication, *Mineral Resources of the United States*, and in a little bulletin abstracted from this, the Geological Survey presents an excellent summary of the state of the world's production of certain of the rare earths, and the present technological standing of these. Zirconium, to which the greater part of the bulletin mentioned is devoted, occurs here and there in the United States, but in view of the regular production from Brazil, which meets the bulk of the demand, it is mined and marketed only intermittently. Since 1902 we have turned out something like nine tons of zirconium minerals, valued at less than $4,000; so it is obvious that any interest we may have in this element is that of a user rather than of a producer.

Metallic zirconium has not so far found any practical uses, although several have been suggested. An alloy with iron, ferrozirconium, has found an application in the steel industry. A zirconium steel is said to be particularly suited for armor plates, armor-piercing projectiles, and bullet-proof metal. An alloy consisting of 65 per cent zirconium, 26 per cent iron, 7.7 per cent aluminum, and 0.12 per cent titanium is said to be highly resistant to chemicals, to be malleable, and to make good filaments for incandescent lamps.

A new patented alloy of zirconium and nickel, free from iron and carbon, has a bright silvery luster and is resistant to acids and alkalis. It is stated to be the best known alloy for use in the manufacture of edge tools of all descriptions, mainly machine tools for milling cutters and cast tools for lathe and plane use. Milling cutters and intricate tools of all descriptions may be cast from this alloy in such forms as to require only a minor grinding operation for finishing. The heat conductivity is higher than for other high-speed metals and the cutting efficiency of the tools is, therefore, increased. The hardness can be varied by changing the proportions of the constitutent metals. An alloy of two to ten per cent zirconium and the remainder nickel is said to take a fine cutting edge. With 16 to 30 per cent zirconium and the remainder nickel or cobalt, the hardness is increased. The melting point and tensile strength are decreased as the proportion of zirconium increases. The addition of molybdenum raises the melting point. It is claimed that no tempering or other treatment is necessary except a slight finishing operation.

The incandescence of zirconium oxide, when heated, has led to its use in certain mantles, glowers, and lights. It was first used in the Drummond light to replace lime, and as early as 1830 an attempt was made to use zirconia buttons, heated to incandescence, for lighting the streets of Paris In 1885 an incandescent gas mantle, composed chiefly of zirconia, was patented, but only a few years later the zirconia was replaced by thoria. About 1,900 zirconia was used in the Nernst glower. At present only a very small quantity is used for lighting purposes. The oxide is used as an opacifier in the enamel industry, and small quantities (from 0.1 to 2.5 per cent), have been added to fused silica ware. The oxide makes a nonpoisonous, non-discoloring white paint of permanency and good covering power, which is not affected by hydrogen sulfide, by acids, or by alkalis. The oxide also finds application in the making of X-ray pictures, and it has also been suggested for use as a polishing powder. Compounds have been used for weighting silk, and the carbide and other compounds, which are very hard, have been suggested as abrasives.

The chief use of zirconium minerals, at present, is as a refractory material, the linear coefficient of expansion of pure fused zirconia (ZrO_2) being 0.00000084. Material made of fused zirconia can, therefore, be subjected to sudden changes of temperature without breaking. Because of the heat-resisting properties and resistance to fluxes and slags, zirconia would seem to be very suitable material for the manufacture of refractory bricks. On this subject a recent trade publication says:

"In manufacturing refractory ware such as crucibles, muffles, combustion tubes, resistance cores, etc., from zirconia, it must always be borne in mind that the material has a very low thermal conductivity. Hence, the walls of the crucible or other shape must be considerably thinner than would be the case if other refractory bodies were used. Owing to the high tensile strength of articles made from zirconia when properly bonded and burnt at a sufficiently high temperature, it is possible to manufacture such ware without unusual danger of breakage through handling.

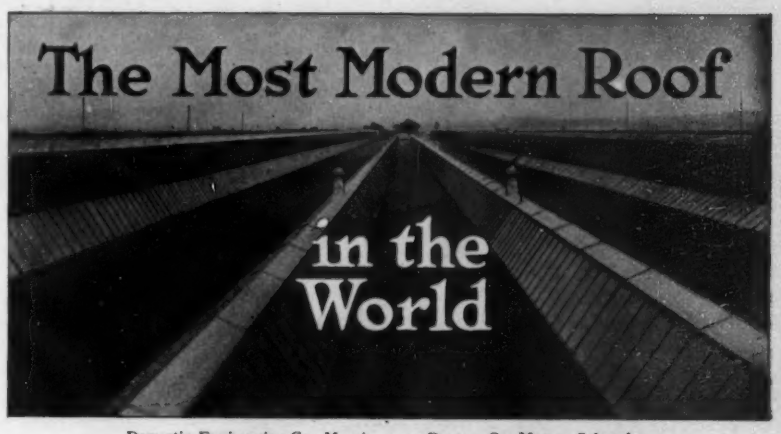
"Prior to 1915 no extensive research work had been done in America on the production of pure zirconium oxide on a commercial scale, but the inability to secure the product from abroad has spurred American investigators to develop commercial processes, so that there is every promise that an oxide running 98 per cent to 99 per cent ZrO_2 will in time be placed on the market at a price in the neighborhood of 60 cents per pound in ton lots. In the preparation of the pure oxide, it is extremely important that it be practically iron, titania, and silica free. Iron is particularly objectionable, as it acts as a flux.

"A recent European patent covers the use of zirconium oxide as a surfacing material for silica, bauxite, or other refractory bricks and products. It is claimed by this process that a thin layer of zirconium oxide, with a suitable binder, renders the coated article highly resistant to slag corrosion. The proper selection of a binder is a very important consideration in the manufacture of bricks and other ware from zirkite. Phosphoric acid, sodium silicate, and lime were tried but with indifferent success, and in many cases it was clearly apparent that such bonds were absolutely detrimental, causing serious fluxing and softening of the zirkite at comparatively low temperatures. In the manufacture of zirkite bricks in standard shapes, about five per cent of a highly refractory clay has been found a satisfactory bond, although a water-ground zirkite has been used as a cementing or bonding material, thus obviating the necessity of introducing binder having a lower melting point than the zirkite. American fire-brick manufacturers, however, have been unable to produce zirkite bricks on a commercial scale, owing to their inability to burn them at high enough temperatures to secure the maximum shrinkage. Most attempts to burn these bricks have been made in silica brick kilns, but with indifferent success. The future for zirkite in refractory bricks is very promising. The work along this line has been highly developed on the Continent and actual tests made on a Martin-Siemens furnace using a zirconia-lined hearth, show that after four months of continuous operation at high temperatures, the hearth was still in good condition and would serve at least four months longer before renewal. The initial cost of zirconia lining is rather high as compared, for example, with magnesite brick, but it is more than offset by its higher melting point, marked resistance to corrosion, low thermal conductivity, and low coefficient of expansion.

The investigations of Dr. Charles Morris Johnson during the past few years have resulted in the manufacture of laboratory ware made from zirkite mixed with other refractory bodies. Zirkite filtering crucibles, muffles, combustion tubes, combustion boats, pyrometer protection tubes and Kipp generators with replaceable units are now on the market at prices comparing favorably with like articles manufactured from German porcelain or fused silica. Zirkite combustion tubes have been reported running in steel testing laboratories for as long a period as three months, being used constantly night and day. Owing to the composition of these tubes they are not attacked by basic substances, do not devitrify, and are gas-tight up to temperatures of 1,000 degrees C."

Coal as a By-Product of Coal Mines

ANY one who has examined bituminous coal as it comes from the mine has observed the brassy yellow nodules and bands which occur in it. Commercially this extraneous mineral is known as pyrite,



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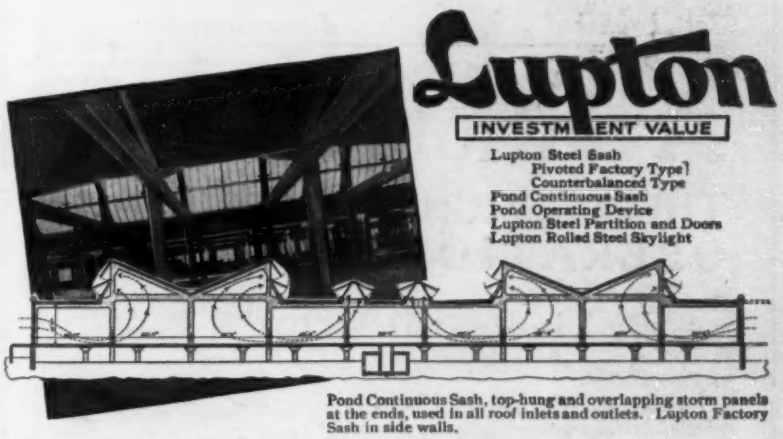

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iron pyrites, etc.; when pure it contains 46.6 per cent iron and 53.4 per cent sulfur. In the ordinary course of mining it is rejected as a deleterious impurity. Its presence in any considerable quantity not only affects the appearance of the fuel, but when burned the pyrite promotes formation of clinkers. Its heating value is small, and the sulfur released in its combustion forms an acid gas tending to corrode tubes and stacks.

When nearly pure pyrite is roasted, the sulfur dioxide gas resulting forms the basis for the manufacture of sulfuric acid. In normal times the commercial supply of this staple is obtained as a by-product in the roasting and refining of sulfurous ores of zinc, lead, or copper. The gas must not be given off to pollute the surrounding country, hence its recovery and utilization is a matter of necessity not regulated entirely by the demand for the acid produced.

Consequently in normal times the market in this country for pyrite has been irregular and limited to small areas near the points of production. Moreover, something like a million tons per annum of Spanish pyrite has been imported in ships which would otherwise have returned to this side in ballast; and again, considerable crude sulfur has been available for acid manufacture. All these factors have affected the general market to such an extent that the demand for pyrite which might be recovered during the mining and preparation of coal has been uncertain. Moreover, since the pyrite must be freed of adhering coal and refuse before shipment, the extra cost of this process has been one more disadvantage in the normal competitive market. So in general little attention has been paid to pyrite recovery by our coal producers.

Since the beginning of the European war conditions have been largely changed. The supply of Spanish pyrite has been cut off, and under present markets a clean pyrite is worth from three to four times as much as the coal with which it occurs. Yet although at the present moment there seems an almost unlimited demand for sulfuric acid and hence for pyrite, it should be remembered that market conditions may change and, with the amount of pyrite available at most mines, large and expensive plants for its recovery are probably not warranted. It seems necessary, therefore, to design and install small plants which will free most of the pyrite from the adhering coal and will otherwise treat it to make it acceptable as a commercial product. It is, however, believed possible for several mines in a district to coöperate, if necessary, in the erection of such a plant, capable of being operated by unskilled labor; and this of course is a great initial advantage.

With the purpose of devising some simple washing or ore-dressing process to effect a separation of the pyrite from its adhering coal, the Department of Mining Engineering of the University of Illinois has undertaken a series of tests with various samples of pyrite. As a result of these tests an arrangement of machines has been worked out, and all cost items have been determined for a simple plant capable of preparing nearly pure pyrite on the one hand, and commercial coal as a by-product on the other. These experiments indicate that a simple plant will recover about eighty-one per cent of the pyrite present, and that if the middlings product of the jig is crushed and retreated, this recovery can be increased to about eighty-seven per cent. The pyrite recovered will average more than forty per cent sulfur, and may be sold directly to chemical or fertilizer companies. The coal recovered as a by-product is not greatly inferior to ordinary screenings. It is easily worth the dollar a ton at which the experimenters have figured it in showing a net profit of $1.55 per ton of raw pyrite on a machine capable of handling 50 tons each day.

The coal produced as a by-product of this novel process contains about eight per cent of sulfur, a part of which is still in the form of pyrite. It is to be remembered that this coal is of screening size, and that its purity depends in the main upon the care with which the pyrite is removed during the process of cleaning.

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AVIATION ENGINES. Design—Construction—Operation and Repair. By First Lieut. Victor W. Pagé, A.S.S.C., U. S. R., Assistant Engineering Officer, Signal Corps Aviation School, Mineola, L. I., New York: Munn & Co., Inc., 1917. 8vo.; 589 pp.; 250 illustrations. Price, $3.

Those who have been seeking vainly for a work embodying the last word upon aviation engines—or at least as final a word as may be expected until peace raises the veil of secrecy—need seek no further. Lieutenant Pagé's splendid monograph is the book of the minute for those alert aeronauts, instructors, engineers and inventors who are satisfied only with the latest and most authoritative information. The student of aviation, from whatever angle he may approach the subject, will find here the ingredients for a thorough grounding in fundamentals, and a very complete disclosure of the fine points of modern practice as they relate to design, construction, operation and repair. The leading manufacturers of aeronautical engines have whole-heartedly cooperated with the author, and the result is a strikingly attractive text perfectly adapted not only to the general student but also to the special and peculiar requirements of military instruction. The urgent need of the day is for a diversified knowledge of the internal-combustion engine, and conditions make it necessary that an adequate degree of expertness should be acquired in the shortest possible time. With this emergency kept constantly in view, Lieutenant Pagé has given to thermo-dynamics only such theoretical consideration as is unquestionably necessary to a proper understanding of engine action. Simply and lucidly he demonstrates the efficiency of the internal-combustion engine, describes and compares the operating principles of the two and four-stroke cycles, shows the various parts and the way in which they function, and illustrates the sequence of operations by ingenious diagrams. A discussion of the properties of liquid fuels leads naturally to the development of the carburetor; numerous plates showing cross-sections of the different types of this device convey construction, principles and operation almost at a glance, and the question of power as affected by high altitude is not overlooked. There is an illuminating chapter on ignition systems, and another on lubrication. Methods of cylinder construction are pictured and described, with a word as to the advantage of off-set cylinders, and some pages are devoted to valve location, installation and operation, engine-timing, and special devices; the constructional details of pistons are set forth and the uses of aluminum are cited. Power plant installation is fully dealt with, and the tools used in erecting and adjusting are illustrated and their uses described. The final chapter, which is so long as to be almost a book in itself, treats of aviation engine types, both American and foreign, and is highly informative; these types are conveniently grouped into three main classes: those engines having a radial or star-wise disposition of the cylinders, the cylinders being stationary; those having a like disposition of the cylinders, but with cylinders and crank-case rotating about the crankshaft; and those that retain the approved automobile design. The leading makes in each classification are profusely illustrated in such manner as to exhibit the internal construction and operation. Throughout the work there are convenient tabulations of important computations and statistics, and of the sources of trouble in the power plant, and a full index furnishes a satisfactory means of ready reference. Nothing dead or moribund encumbers the treatise; accurate and practical instruction alone finds a place. The author has made the internal-combustion engine his specialty, and has learned the best methods of conveying his ideas from years of actual writing and teaching; his mastery of the subject and of the medium of expression is evident on every page, and the volume should take its place as the foremost contribution to the educational literature of aviation.

THE KILN DRYING OF LUMBER. A Practical and Theoretical Treatise. By Harry Donald Tiemann, M.E., M.F., U. S. Forest Service. Philadelphia and London: J. B. Lippincott Company, 1917. 8vo.; 327 pp.; illustrated. Price, $3 net.

Trees contain from 30 to more than 200 per cent of the dry weight of the wood in water, and for most uses this water must be voided; air drying is a slow and incomplete method, and the dry kiln must often be resorted to; this conditions the wood for the purpose to which it is to be put, reduces the losses occurring in air drying, reduces the time necessary to carry stock in the yard, and reduces shipping weights. The various efficient methods are set forth in this work, and when lumber dealers come, as eventually they must, to the establishment of standards, the architect or engineer may specify exactly the moisture contents of wood and the manufacturing and casehardening conditions, with the assurance of getting precisely what he needs for any particular purpose. Wood users will agree that this standardization is a consummation devoutly to be desired, and the work in hand contributes largely to that end.

RADIO COMMUNICATION. Theory and Methods. By John Mills, Member, Institute of Radio Engineers, etc. New York: McGraw-Hill Book Company, Inc., 1917. 8vo.; 216 pp.; illustrated. Price, $1.75 net.

This work has strong claims to attention. In the first place it must be classed with war-emergency literature, in that it is based upon lectures to a company of the U. S. Reserve Signal Corps troops, and is admirably adapted to the instruction of our expeditionary forces; in the second place, and following naturally from the above premises, it equips the student with tools of analysis that are usually available to him only after long drill in calculus and differential equations. Very simply it develops and uses for this purpose two concepts, the vector operator "j" and the differential operator "p," both of which are made familiar to the student by homely but striking and apt illustrations. Thus elementary algebra and a limited knowledge of physics are alone necessary to an understanding of the fundamentals.

BOOKLET OF PRINTS. New York: German American Insurance Company. 8vo.; illustrations.

There is no text to this booklet of drawings other than the brief explanatory notes carried by the sketches themselves; these show in a graphic manner the approved standards for gas stoves, piers and pillars, chimney construction, coal stoves and gas lights, and for many other common sources of danger from fire. Safe and unsafe arrangements are pictured, and householders and factory owners alike may find in the prints many suggestions that will safeguard property and human life at a minimum expenditure of trouble and expense.

THE ATTACK IN TRENCH WARFARE. By Captain André Laffargue, 153d Infantry, French Army. New York: D. Van Nostrand Company, 1917. 16mo.; 86 pp.; illustrated. Price, 50 cents net.

This study of actual methods of attack as developed within the period of the war is translated from a work that was so highly esteemed by General Joffre that he ordered its circulation among the French troops before releasing it for general publication. The character of the attack has become that of siege warfare, and it is from this point of view that Captain Laffargue treats it. The German defensive organization is described, and artillery preparation and its objects are categorically given; the form of attack is dealt with under first and second line requirements; the cohesion and offensive spirit necessary to successful penetration is set forth; the material preparation of the troops, from knowledge of the ground to action of the second line of attack is discussed; and the meaty little work concludes with the development and physiognomy of the attack. Folding diagrams make clear the problems and progress of a typical forward movement, and the book fully justifies the high praise bestowed upon it by Captain Lynch, who contributes an introduction brief but decidedly to the point.

BUSINESS LAW FOR ENGINEERS. By C. Frank Allen, Member American Society of Civil Engineers, etc. New York: McGraw-Hill Book Company, 1917. 8vo. Price, $3 net.

While it is not advisable for the engineer to usurp the functions of the lawyer, there are many instances where some understanding of legal fundamentals would be of incalculable benefit. The training of the author enables him to combine the viewpoints of the lawyer and the engineer, and thus to extend valuable aid to the latter. The first part of his work deals with such topics as equity, real property, corporations, and railroads, concluding with a discussion of the engineer's legal relations with others, whether as employer, employee, agent, or contractor; the second part takes up contract letting, from the preparation of forms for the advertisement to contract forms, bonding and specifications.

HOW TO LEARN EASILY. By George Van Ness Dearborn. Boston: Little, Brown & Company, 1916. 16mo.; 221 pp. Price, $1.

The field of human knowledge is so vast, and the amount of knowledge that every well-informed person should possess so great that economical methods of study are imperative to enable one to acquire a fair modern education within the period ordinarily available. The present volume considers the problem analytically and psychologically, and points out methods by which the best results may be secured from study with the least expenditure of time and effort. A large portion of the matter in this volume appeared serially in the SCIENTIFIC AMERICAN SUPPLEMENT last year, but much new matter has been added making the present work more comprehensive. It contains many helpful suggestions of value to both student and instructor alike.

ALL ABOUT ENGINES. By Edward Cressey. New York: Funk & Wagnalls Company. 8vo.; 368 pp.; 183 illustrations. Price, $2 net.

The mechanical and industrial supremacy of the future is in the hands of the rising generation. The once popular "Helen's Babies" tells the story of two young hopefuls who were always wanting "to see the wheels go 'round;" they were but types of the normal youngster. Unless, however, this normal instinct is fed by simple explanation and satisfied by enlarging knowledge, the eager mind is fatigued by confronting difficulties, and loses interest. This attractive work, "All About Engines," is designed to simplify machinery for the boy, and to place within his grasp the basic principles of the steam engine, the turbine, the gas engine, the locomotive, and the oil engine, and to convey some knowledge of power and its measurement and fuel and its problems. There is a little brightly-written history, every device is stripped down to its working essentials, and the diagrams and plates have been carefully prepared with a view to the natural limitations of the youthful mind.

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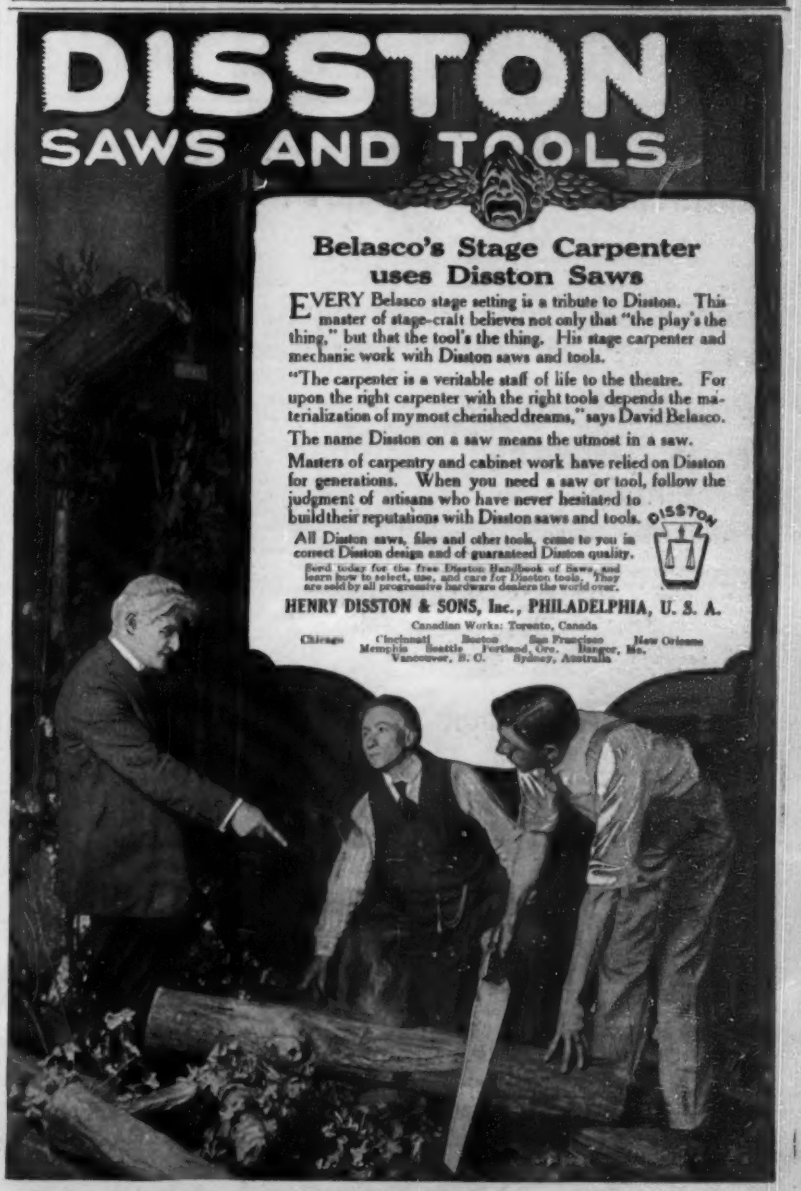
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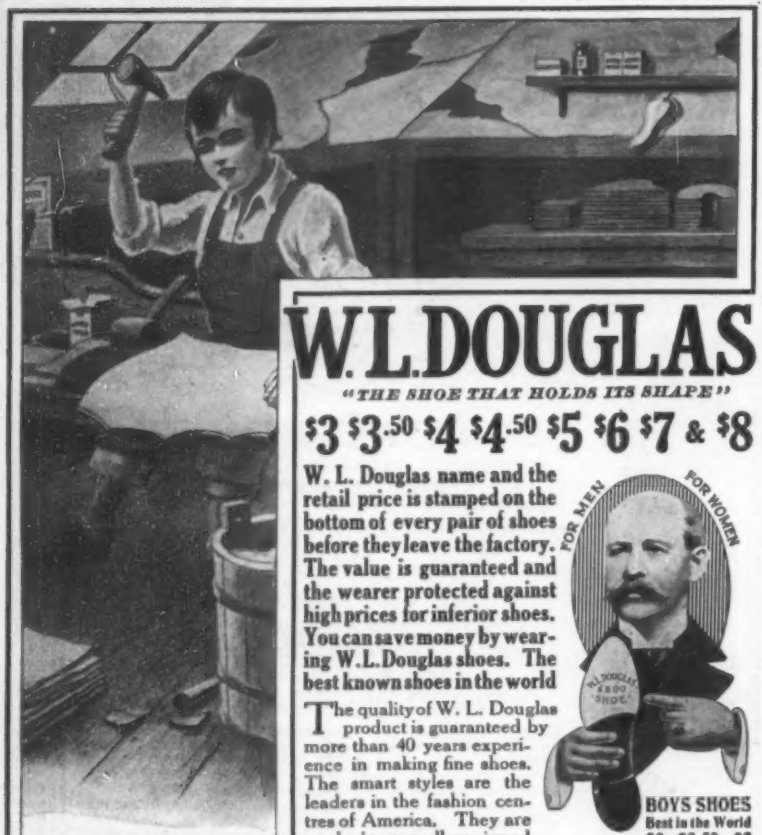

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(14274) W. S. B. asks: *In photographing lightning flashes, occasionally they come out black instead of white in the positive.* Can you tell me where I can find any literature bearing on the subject? How about the SCIENTIFIC AMERICAN SUPPLEMENTS? I take the liberty of troubling you with this question on the strength of this being my 59th year of subscription. A. You will find in the SCIENTIFIC AMERICAN of August 31st, 1912, the explanation of the Dark Flashes of Lightning, so-called, which are frequently found in Photographs of lightning flashes. They are a case of reversal, where a positive results in place of a negative. There is no dark lightning. It is a trick of the photographic plate, due to overexposure. This effect was produced artificially in 1889 by Mr. Croyden, an English Photographer, who used electric sparks in his experiments, and showed that with a proper degree of illumination a positive resulted instead of a negative. The matter is fully described in the article referred to, which you probably have in your file.

(14275) F. N. asks: Can you furnish me with a table telling the differences of resistences of an electric current in wires of the same sizes, but of different metals, such as brass copper, iron, steel, aluminum and other metals. What I want to find out is the difference between copper and aluminum. What is the difference of resistance of a copper wire and of an aluminum wire of the same size and weight. Is it one-half or what it is kindly furnish me with this information if you can. A. The resistance of wires of the same size but of different metals is called the specific resistance of the metal. Tables of specific resistances are to be found in all books of electrical tables. Such a table is given in Pender's American Hand-book for Electrical Engineers, pages 1223–1224. We will send you the book for $5 postpaid. The specific resistance of copper, the annealed standard, is 1.589, and of aluminum is 2.62. These numbers are the michroms of resistance of cubic centimeter of the metal at the temperature 0 degrees Centigrade. To find the resistance of aluminum in terms of copper, you will divide the 2.62 by 1.589. The quotient is 1.65 nearly. So the resistance of aluminum is about 1½ times as much as that of copper under the same conditions, at the freezing point.

(14276) E. J. C. asks: In the plant at which I am employed there has arisen a great controversy as to the answer to the following question: $1 \div 0 = ?$ or, stated in words, what does one divided by zero equal. Some of the boys (myself included) say that zero will go into one an infinite number of times while others claim that $1 \div 0 = 1$ and still others say that $1 \div 0 = 0$. In the end all agreed to accept the SCIENTIFIC AMERICAN as authority and I am writing this to request that you settle this point for us. The whole operating force of a large power plant is involved in this argument. Inclosed please find stamp for reply which I assure you will be very much appreciated. A. You are quite right in saying that $1 \div 0$ gives infinity for a quotient. You can demonstrate this result in this way:

$$1 \div 1 = 1$$
$$1 \div .1 = 10$$
$$1 \div .01 = 100$$
$$1 \div .001 = 1{,}000$$
$$1 \div .0001 = 10{,}000$$

The smaller the divisor the larger, etc. to any extent, the quotient becomes in the same ratio. Therefore, if the divisor be reduced to zero the quotient will become larger than can be imagined or infinity. One divided by 1 is 1, and 0 divided by 1 is zero. So too is zero divided by any other number, as 0 divided by 5. If 5 heirs have nothing to divide among them each share will be zero.

(14277) A. W. P. asks: I am a constant reader of your scientific journal and would like to know if you could tell me the factor used in determining the food value or calories of food stuffs and whether it is multiplied by the protein or fat content of the article in question. If you have a catalog of your books and publications I would be glad to receive one. A. The calory is not the food value but the *heat* value of food. The calories specified are the quantity of heat, given by a given weight of an article of food, if completely burned, since a calory is the quantity of heat which will raise one gramme weight of water one degree Centigrade. You will see that this involves the combustion of all the components of the article. The fat is a large component of food in yielding heat by its combustion, and more calories are given by the fat than by the same weight of other components. Poth the proteins and the fats contain carbon, hydrogen and oxygen, and therefore will burn readily. The proteins also contain nitrogen and sometimes sulfur and phosphorus, both of which last will burn and yield heat. Many vegetable foods contain also large percentages of carbohydrates which of course are easily combustible and add to the total of calories. The July 28th, 1917 issue has a valuable article on fuel foods. Mailed on receipt of 10 cents.

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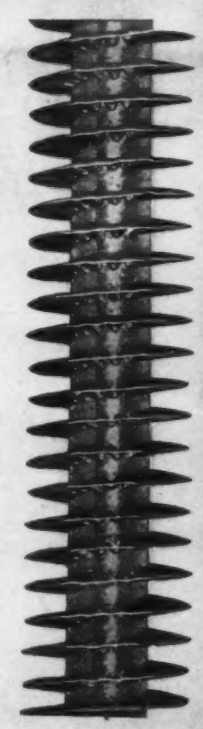

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RAMMING A U-BOAT BY FOLLOWING THE WAKE OF ITS TORPEDO [See page 273]

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